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Symposium on Gastric Surgery

Introduction

DURING the last half century great advances have been made in gastric surgery. One can best view this progress from the vantage point of a review of this surgery written in 1904 by Frederic S. Dennis [1], Professor of Clinical Surgery at Cornell University Medical School and read before the International Congress of Arts and Sciences in St. Louis.

Much emphasis was placed on surgery for gastroptosis and plication of the stomach for dilatation. One particularly quaint operation was advised for hysterical vomiting: "Hysteria, as is well known, gives rise to persistent and uncontrollable vomiting and in one case in which no relief could be obtained by medical means, a laparotomy was performed, the stomach drawn out and then returned into the peritoneal cavity. The psychic effect or the mechanical stretching of the stomach itself resulted in cure."

Gastrostomy was performed to prevent death from starvation: "There can be no more beautiful illustration of the development of surgery than is demonstrated in this one operation, since formerly it was attended by a mortality rate of 100 per cent, while today after about a quarter of a century the operation has by evolution achieved a record that is most remarkable, since the latest figures show the mortality to be less than 30 per cent."

Gastric ulcer was coming into the surgeon's domain: "Gastric ulcer is a pathologic condition which formerly was considered exclusively from a medical point of view. Today this disease in the stage of complication has been relegated to the domain of surgery. It has been during the past quarter of a century that progress has been made in the management of serious complications, such as hemorrhage and perforation of this intractable disease. Under medical treatment, the mortality of gastric ulcer in hemorrhage or perforation was nearly 100 per cent, while under surgical treatment this frightful mortality has been reduced by the Mayos to 5 per cent in the benign ulcers and 18 per cent in the malignant ulcers. The advance that surgery has made in this disease has been in the study of the mechanics of the stomach, rather than the chemistry. Medical treatment based on chemistry was of little avail, . . . In addition to the reduction of the mortality . . . there has been eliminated the danger of cancer engrafted upon an ulcer which at the beginning was benign."

Dennis cited the three main reasons why surgeons have been reluctant to attack cancer of the stomach, an invariably fatal disease which makes up "40 per cent of all the cases of cancer that invade the human body."

The first reason was the belief that cure cannot be accomplished. Dennis opposed this with Murphy's collection of 189 cases in which three-year survivals were obtained in 5 per cent of patients together with Kronlein's statistics: "that human life is prolonged fourteen months over the unoperated cases."

The second reason was: ". . . the high mortality rate of 60 per cent which Billroth published," and he refuted this with Mayo's latest figures of 10 per cent. "This one fact alone is the grandest and most striking proof of the miraculous work which surgery has accomplished, and to Mayo is due the credit of leading the world in this new department of surgery, which may be said to be the highest,

the final, the most triumphant monument of the contribution of surgery to the human race."

The third reason was: " . . . that diagnosis cannot be made by medical means in time to effect a cure. Exploratory incision is recommended by Mayo."

Dennis even had a word for prophylactic treatment: "Mikulicz has shown that 4 per cent to 5 per cent of the human race suffer from gastric ulcer, and that a fifth die as a result of the gastric ulcer. The other factor which largely influences the growth of cancer is the pyloric stenosis when the stomach cannot empty itself. The suggestion, therefore, is the removal of gastric ulcers by excision, and the relief of the pyloric obstruction by gastroenterostomy, and these prophylactic operations when performed early are attended with a comparatively small mortality, and eliminate the possibility of cancer of the stomach arising from these two important and frequent causes."

During the succeeding half century many important advances in surgical technic, pre- and postoperative care and diagnosis together with increased knowledge of gastric physiology and biochemistry have changed many of these opinions. Nevertheless, there are still many problems. Gastric resection is a high price to pay for a benign lesion. Surgery for massive hemorrhage leaves much to be desired. The diagnosis of cancer often is made too late. Surgical attack on the cancer, while not as futile as just outlined, does not yield cure rates that please the surgeon. Prophylaxis of gastric carcinoma has not advanced at all.

In order to impart current concepts concerning many aspects of gastric surgery, the proceedings of the seventh annual Third (Boston University) Surgical Service Seminar, Boston City Hospital, are presented. I wish to thank the participants for the time and effort spent in preparing these presentations for delivery and publication.

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Gastric Ulcer

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ALTHOUGH a great deal has been written about gastric ulcer, a lack of agreement exists regarding interpretation of these data and management of the disease. The pathologically proven incidence of malignancy reported for surgically treated patients with gastric ulcer has varied between approximately 10 and 20 per cent (Table 1); however, many gastroenterologists and roentgenologists now consider these figures to be too high because of recent advances in diagnostic acuity.

It must be pointed out that not all patients with gastric ulcer are treated surgically. When operation is performed it is because a definite diagnosis of benignancy or malignancy cannot be established, or because the ulcer failed to heal or recurred following medical management. Therefore, the reported 10 to 20 per cent incidence of carcinoma is too high since it excludes those patients with gastric ulcer treated conservatively without surgical intervention.

TABLE 1
INCIDENCE OF MALIGNANCY IN GASTRIC ULCER*

Author	Year	Per cent
Morley [15]	1923	10.0
Finsterer [6]	1939	20.9
Allen and Welch [1]	1941	14.0
Eusterman [5]	1946	13.4
Marshall and Welch [13]	1948	19.8
Smith and Jordan [18]	1948	16.3
Lampert et al. [10]	1950	13.0
Ekström [4]	1952	11.6
Cain et al. [2]	1952	10.4
Marshall [12]	1953	15.8
McGlone and Robertson [14]	1953	12.3
Runyeon and Hoerr [16]	1957	21.8
Marshall, Jensen and Davidson (present series)	1961	13.2

* In each case the diagnosis was proved by operation and pathologic examination.

A more accurate figure for the incidence of malignant gastric ulcers in a group including both surgically and medically treated patients is about 5 per cent.

Jordan [8] commented on the 20 per cent rate of unsuspected malignancy in ulcers that appear to be benign reported by Runyeon and Hoerr [16]. He stated that this figure was "even in excess of cases diagnosed as suspected of malignancy because of intractability under a short period of trial management of recurrence." Kirsner et al. [9] believe that "gastroscopy, roentgenology, and exfoliative cytology should give a correct diagnosis in 95 per cent of the cases." The treatment of gastric ulcer has remained inconsistent. A minority [19], chiefly surgeons, advocate that all patients with gastric ulcers should be treated surgically. Others [9] among our medical associates maintain that only a small percentage need surgical intervention. To help clarify these inconsistencies of opinion regarding diagnosis and treatment, we report our experience in the surgical treatment of gastric ulcers.

MATERIAL

Marshall [12] (1953) reported 411 cases of gastric ulcer treated surgically at the Lahey Clinic up to 1951. Since then (1951 through 1959) an additional 296 patients have been

TABLE II
COMPARISON OF BENIGN AND MALIGNANT GASTRIC ULCERS

Type of Ulcer	No. of Cases	Per cent
Benign	614	86.8
Malignant	93	13.2
Total	707	100

TABLE III
INDICATIONS FOR OPERATION—BENIGN GASTRIC ULCER

Indication for Operation	No. of Cases
Carcinoma	57
Inability to exclude carcinoma	185
Recurrence of gastric ulcer	157
Failure to heal	111
Pyloric obstruction	54
Hemorrhage	39
Incidental finding at laparotomy	9
Perforation	2
Total	614

operated on. This total of 707 cases consisted of 614 (86.8 per cent) cases of benign ulcer and 93 (13.2 per cent) cases of malignant ulcer. (Table II.) The main indications for surgery were inability positively to exclude carcinoma, failure of the ulcer to heal under conservative medical therapy, and recurrence. (Tables III and IV.) There was no significant sex link associated with either benignancy or malignancy. (Table V.) Males predominated with both types of lesions. The age incidence (Table VI) was similar in both, being greatest in the 40 to 70 year bracket with an average age of 53.5 years (Table VII). The duration of symptoms varied greatly. Of the patients with malignant ulcer, 66 per cent had had symptoms for over one year and 45 per cent for over five years. Only 34 per cent had had symptoms for less than one year. The duration of symptoms in the benign ulcer group was over five years in 35 per cent, over one year in 63 per cent and under one year in 37 per cent. The location of either benign or malignant ulcers is, in general, only suggestive as to their nature. For both lesions the most frequent sites were the lesser curvature and the pyloric area. The type of operation performed most frequently was a Billroth II partial gastrectomy removing two-thirds of the stomach, with an antecolic Hofmeister type of anastomosis. Recurrence after this operative procedure was so rare that we now believe a 50 per cent resection using a Billroth I type of anastomosis can be performed safely in many cases if the ulcer is not malignant or is not located high on the lesser curvature or in the cardia. There were fourteen total gastrectomies for benign ulcer, only one of which was performed in the past seven years, with one death. The mortality for the total

TABLE IV
INDICATIONS FOR OPERATION—MALIGNANT GASTRIC ULCER

Indication for Operation	No. of Cases
Carcinoma	1
Inability to exclude carcinoma	56
Recurrence of gastric ulcer	19
Failure to heal	10
Pyloric obstruction	7
Total	93

TABLE V
SEX INCIDENCE—OPERATED CASES OF GASTRIC ULCER

Type of Ulcer	Men	Women	Ratio*	Total
Benign	417	197	2.1:1	614
Malignant	67	26	2.6:1	93
Total	484	223	...	707

TABLE VI
AGE INCIDENCE—OPERATED CASES OF GASTRIC ULCER

Age by Decades (Yr.)	Benign Cases	Malignant Cases
20–29	5	2
30–39	58	7
40–49	156	18
50–59	222	39
60–69	131	23
70–79	39	4
80	3	0
Total	614	93

TABLE VII
AGE AND TYPE OF LESION

Gastric Ulcer	Age (Yr.)
Benign ulcer	53.4
Malignant ulcer	53.7
Youngest with carcinoma	20
Youngest with benign ulcer	26
Oldest with carcinoma	79
Oldest with benign ulcer	82
Average age	53.5

series of 707 cases was 2.1 per cent. The mortality among the patients with benign lesions was 2.6 per cent (seventeen deaths) and among the patients with malignant lesions, 1.1 per cent (one death).

COMMENTS

There are great similarities in our statistics concerning benign gastric ulcer and ulcerocancers. The age, sex, duration of symptoms and roentgen findings frequently fail to differentiate an early ulcerocancer from a benign lesion. The location of the lesion is not as helpful as was once thought. The greater curvature, fundus and prepyloric areas have been considered the most likely sites for malignant ulcer. In our series twenty-three ulcers were located on the greater curvature of which only five (22 per cent) were malignant, seventeen in the fundus of which eight were malignant, and 254 in the prepyloric area of which thirty-six being malignant. Similarly, the lesser curvature has been considered the usual location for benign ulcers. In our series 413 ulcers were found in this region, of which forty-four were malignant. Even the size of the ulcer was only of suggestive significance. In general, the ulcerocancers tended to be larger than the benign ulcers. However, 51.8 per cent of the ulcerocancers were less than 2.5 cm. in diameter, the smallest being only 0.5 cm. Conversely, 21.8 per cent of the benign ulcers were more than 2.5 cm. in diameter. The largest benign ulcer measured 8 cm. Turner et al. [20] reported on a clinicopathologic study of 100 cases of benign gastric ulcers measuring more than 4 cm. in diameter treated surgically at the Mayo Clinic. In their series these large benign gastric ulcers represented 4.1 per cent of the total number of gastric ulcers treated surgically.

At operation, but before resection, the surgeon stated his opinion as to whether the lesion was benign or malignant in twenty-four of these cases. An incorrect diagnosis of carcinoma was made in thirteen (54 per cent) illustrating the diagnostic difficulties present even at the operating table. Small ulcers may also be difficult to assess. A few of those encountered in our series were thought to be benign at the operating table, and we were later surprised when the pathologic report indicated malignancy. Comfort et al. [3] made an excellent study of small gastric cancers at the Mayo Clinic. Of 924 patients with adenocarcinomas of the stomach treated by gastric resection, the lesion was less than 4 cm. in diameter in 226 (24 per cent). The smaller ulcers were studied further and the conclusions were as follows: the smaller the growth, the lower the incidence of high grades of malignancy and of metastases; the higher the incidence of pain and the longer the duration of symptoms, the higher the gastric secretory activity with greater lack of roentgenologic features of malignancy. These findings clearly indicate the difficulty in differential diagnosis. The importance of early operation was shown by the fact that the five-year survival rate of the group with ulcers less than 4 cm. in diameter was 44.7 per cent, and for patients with ulcers 1 cm. or less it was 82.4 per cent. The five-year survival for the total series of 924 patients with gastric carcinomas treated by gastric resection was 31.6 per cent.

The relation of gastric ulcer to duodenal ulcer has interested many physicians. Duodenal ulcer is generally believed to develop when acid hypersecretion, hypertonicity, and rapid gastric emptying are present. Conversely, it is thought that gastric ulcer usually develops in a stomach with normal secretion or hyposecretion, hypotonicity, and slow gastric evacuation. Johnson [7] studied 135 cases of concomitant gastric and duodenal ulcers. He found that these patients gave long histories of dyspepsia and had acid hypersecretion characteristic of duodenal ulcer alone. Sixty-four per cent had definite pyloric stenosis and gastric retention. In 93 per cent evidence indicated that the duodenal ulcer had developed before the gastric ulcer. These gastric ulcers secondary to pyloric stenosis enlarged rapidly, bled in 47 per cent of the cases, and responded poorly to medical management. The incidence of concomitant gastric and duodenal ulcer in our series was 9 per cent. We agree with Johnson that early surgery is indicated for all patients with concomitant ulcers.

We do not recommend surgery in all cases of gastric ulcer. If the patient has not had severe symptoms and the ulcer appears benign on roentgenologic study, a short trial of medical therapy is indicated. We hospitalize all such patients so that close supervision and careful medical management can be assured. If progressive healing is not demonstrated by roentgenology and gastroscopy, if occult blood does not disappear from the stool and symptoms do not subside, operation should be performed. It

is well known that an ulcerocancer may decrease in size when treated medically. It is essential, therefore, to make certain that the ulcer has completely healed, and it must be shown to remain healed by frequent follow-up examinations after hospital discharge. Failure to heal or recurrence is a definite indication for prompt surgery. Levin et al. [*11*] stated that "the incidence of gastric neoplasm in patients with chronic recurrent benign gastric ulcer does not exceed the frequency of gastric neoplasm in the general population." To us this statement sounds risky. We have operated on 176 patients for recurrent gastric ulcer and have found twenty (11.4 per cent) to be malignant.

The surgical treatment of gastric ulcers should consist of partial gastrectomy removing about 50 per cent of the stomach in most cases. Usually, the omentum should be removed. The spleen need not be resected unless the ulcer is near the splenic pedicle or nodes in that region are palpable. Total gastrectomy is not recommended. An ulcer high on the lesser curvature can usually be removed without total gastrectomy if careful dissection and oblique division of the stomach are performed to retain as much of the fundus and greater curvature as possible. The Madlener operation in which two-thirds of the stomach is resected and the ulcer is retained is never utilized. Vagotomy is not indicated as the stomach is hypotonic without high gastric acidity in most patients. In a thin person with low gastric acidity and a high ulcer it is desirable to retain as much stomach as possible. Under these circumstances a 50 per cent resection to include the ulcer (Billroth 1 anastomosis) may be the best method. Turner et al. [*20*], in their discussion of the treatment of large penetrating ulcers, recommended fresh frozen section. If the lesion is benign on frozen section, it is preferable and safe to leave the ulcer base adherent to adjacent organs such as the liver or pancreas. We have done this occasionally. Levin et al. [*11*] reported on 116 patients with gastric ulcer treated by a strict medical regimen supplemented by irradiation of the body and fundus of the stomach. They were able to reduce gastric acidity by 50 per cent or more in 80 per cent of their patients; however, the reduction lasted less than one year in 64 per cent of the cases. Moreover, the ulcer failed to heal in eight and recurred in forty-six. Gastric malignancy developed in only two of their patients, an incidence of 1.7 per cent. We have not seen any other reports with an incidence of malignancy that low. Smith et al. [*17*] reviewed 1,000 cases of gastric ulcer at the Lahey Clinic and found that 578 (57.8 per cent) of the patients were treated surgically and 422 (42.2 per cent) medically. It appears that the percentage of patients treated surgically has been gradually increasing. We believe that about 60 to 65 per cent of patients with gastric ulcer should undergo operation.

SUMMARY

1. At the Lahey Clinic 707 patients with gastric ulcer were treated surgically. The incidence of malignant disease was 13.2 per cent.

2. There were no significant differences in sex, age, or duration of symptoms between patients with benign and those with malignant ulcer.

3. The location and size of benign and of malignant ulcers differed slightly.

4. The treatment of patients who have uncomplicated gastric ulcer should consist of hospitalization and a trial of medical therapy. Failure of the ulcer to heal completely or recurrence are indications for prompt surgical intervention.

5. The surgical treatment recommended is excision of the ulcer by a moderate partial gastrectomy.

6. The mortality for our entire series was 2.1 per cent.

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DISCUSSION

JOHN J. BYRNE (Boston, Mass.): The main purpose in having a relatively small number of papers during the course of an entire day is to allow for a discussion period after each paper, so that some of the points that the speaker made can be reviewed and other portions of his talk probed more deeply.

In Dr. Marshall's first slide, I saw that Dr. Hoerr reported a cancer incidence of over 20 per cent. I wonder if he would comment on this problem.

STANLEY O. HOERR (Cleveland, Ohio): I do not think that internists are any less accurate than others in differentiating cancer from ulcer since our figures do not include all patients with gastric ulcer. We operate on approximately 40 per cent of patients with gastric ulcer. If we included all the patients followed up by their physicians, I think the figures probably would be closer to 10 per cent.

I agree with Dr. Marshall's opinions on gastric ulcer. I remember one of the first patients that I operated on for a benign ulcer. A frozen section in the operating room showed cancer. Twenty-two additional sections were run on that ulcer, none of which showed cancer. The pathologist thought that a mistake probably had been made in the frozen section. However, cancer was found in one lymph node.

If the pathologist has that much trouble, it is difficult for me to see how the physician can reduce the incidence much below 5 per cent.

CLAUDE E. WELCH (Boston, Mass.): I am in almost complete agreement with Dr. Marshall. We have an incidence in medical and surgical patients of approximately 8 to 9 per cent error in the diagnosis of benign ulcer. We operate on about 60 per cent of all of the cases. Perhaps this is a little high because we see many patients with massive hemorrhage.

I would subscribe to the statement that some of these patients do not need to be operated upon, but I still think that we ought to operate more frequently than we do. Some physicians think that gastric ulcer is a duodenal ulcer and are not quite as aware of the dangers of these ulcers as gastroenterologists. As a consequence, they are prolonging medical treatment.

STANLEY O. HOERR: We should remember that some patients are not going to return for follow-up studies. I think these patients should have an operation and that this is as important an indication for surgery as suspicion of malignancy on the roentgenograms. It is the physician's responsibility to teach the patient that follow-up is vital. If he is an itinerant workman, he may lose that patient's only chance for life.

Our experience with prognosis in the group of patients operated on to exclude cancer is not quite the same as Dr. Marshall's. In our group, the five-year survivals are about four times as frequent as they are when the preoperative diagnosis is cancer.

JOHN J. BYRNE: I was interested in Dr. Marshall's comments concerning gastric ulcer associated with duodenal ulcer.

SAMUEL F. MARSHALL: We do not, of course, see many cases of this, but the duodenal ulcer usually came first if we do find an associated duodenal ulcer. Then the gastric ulcer develops rapidly and often bleeds.

We have had such a coincidental involvement in 9 per cent of our gastric ulcers. I am of the impression that the percentage of malignancy would be nearly 44 per cent.

JOHN J. BYRNE: Let us forget the problem of malignancy for the moment. Are there any indications as to whether or not a certain gastric ulcer will heal or become intractable? For instance, I think gastric ulcers which penetrate the gastro-hepatic omentum do not heal well.

JOHN J. MARSHALL: I agree that they will not heal. We have treated some very large gastric ulcers. Recently, we saw one that measured 12 cm. and perforated against the liver. Healing would have been impossible.

We often find ulcers penetrating into the pancreas. That becomes a problem, too, because one does not know whether or not the penetration is

malignant. The pathologist can help you a great deal. When the lesion is benign, I usually separate the penetration along the periphery of the defect in the stomach since it is not necessary to excise the base. Of course, the base must be excised if the ulcer is malignant.

JOHN J. BYRNE: Are there any other qualities about an ulcer other than this excavating penetration that might indicate that it is not going to heal?

SAMUEL F. MARSHALL: I think that an ulcer along the lesser curvature and high on the cardia will not heal because it is subjected to trauma and heavy peristalsis. I certainly think that ulcers in other locations may heal and that healing will occur very rapidly.

GEORGE L. JORDAN, JR. (Houston, Texas): I would like to express a more radical approach to this problem. In fact, we resect all of them that we can get away from the internist.

Our main reason for resection is not the danger of carcinoma, but the natural history of the ulcer. We believe that gastrectomy can now be performed with a low operative mortality. The medical treatment of gastric ulcer is attended with a higher mortality than surgical treatment. This fact is commonly overlooked.

Secondly, even small, apparently benign gastric ulcers have a high incidence of recurrence. After surgery the incidence of recurrence is practically nil.

Most patients feel well after gastrectomy for gastric ulcer. Postgastrectomy symptoms are not common and are rarely severe.

Thus, we believe that we have more happy, well nourished, working patients with fewer periods of hospitalization after surgery for gastric ulcer, irrespective of the incidence of malignancy, than the doctor who treats these patients medically.

JOHN J. BYRNE: Dr. Jordan, would you please extend that remark that there is a higher mortality with medical treatment? Do you mean just a relationship to carcinoma or do you mean malnutrition?

GEORGE L. JORDAN: I mean hemorrhage, perforation and obstruction, with the most deaths due to hemorrhage. In our institution at the present time the mortality for gastrectomy for gastric ulcer is less than 1 per cent. In those patients who have been treated medically, the mortality rate is 4 per cent from complications of the ulcer.

RICHARD T. SHACKELFORD (Baltimore, Maryland): There is only one problem I wish to comment on, the perforated gastric ulcer. Last week I saw a perforated gastric ulcer which the surgeon just sutured. The man suffered another perforation about six or seven days postoperatively. This time we operated on him and found a malignant ulcer.

I believe that one should be reasonably sure that a perforated gastric ulcer is not malignant before just performing simple closure.

JOHN J. BYRNE: Dr. Marshall mentioned that an ulcer near the cardia can always be resected. Do any of the other members of the panel have anything to add to the discussion of this particular problem?

STANLEY O. HOERR: I think this is one point of disagreement. I have not treated many ulcers that are very high. There is usually a little space between the esophagus and the edge of the ulcer and resection should be performed in these cases. If it is right at the edge of the esophagus and if one is going to perform resection of the stomach, the patient is subjected to esophagogastrectomy, which is no minor procedure.

I do not believe that I have seen this done more than once or twice, but I have opened the stomach and taken a biopsy in several representative areas. If the frozen section is normal, I leave the ulcer alone and perform a distal 50 per cent gastrectomy with confidence that the ulcer will heal.

CLAUDE E. WELCH: Among approximately 225 operations for gastric ulcer, four were esophagogastrectomy, one was total gastrectomy, and all the rest were distal gastrectomy. This shows that it usually is possible to treat them by this standard technic which Dr. Marshall mentioned.

GERARD N. MICHAUD (Salem, Mass.): What is Dr. Jordan's rate of resections?

JOHN J. BYRNE: It seems to be 100 per cent.

GEORGE L. JORDAN: Of those that come to the surgical service, it is 98 per cent.

Gastrostomy

CLAUDE E. WELCH, M.D., *Boston, Massachusetts*

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GASTROSTOMY, one of the standard operations on the stomach, has a long and interesting history. Since its introduction over a century ago, numerous technical modifications of the procedure have been introduced and developed. Meanwhile, the indications for its use have been modified sharply with the passage of time since it has become apparent that certain problems are inherent in gastrostomies and the indications for their use have changed. In this brief review the various types of gastrostomy will be considered and their advantages and disadvantages described.

Inasmuch as the popularity of gastrostomy has waxed and waned because of definite trends in the treatment of certain diseases, it will be advantageous to discuss the problem from an historic viewpoint first. The early history of this operation has been summarized in a recent review by Farris and Smith [*1*]. They note that Egeberg [*2*] first proposed this operation as a palliative procedure for cancer of the esophagus in 1837. Sedillot [*3*] (1849) performed the first operation in man but it ended fatally. In 1876 Verneuil [*4*] obtained the first operative survival after many unsuccessful attempts. However, the first gastrostomy that led to a series of clinical successes was that introduced by Witzel [*5*] in 1891. He showed that the formation of a gastric tunnel which protected the entrant opening of the catheter, and a careful suture of the stomach to the anterior wall, were the most important factors in success. Slightly different methods of suture were developed by Stamm [*6*] in 1894 and Kader [*7*] in 1896. All of these early methods required the use of a catheter and were used essentially as palliative procedures for cardiac obstruction due to cancer of the esophagus. Replacement of the catheter often was a troublesome procedure, and sometimes the gastrostomy would close due to stenosis.

Accordingly, the next technical development eliminated the use of catheters. Janeway [*8*] (1913) made a flap from the anterior wall of the stomach and thus brought a fistula, lined by gastric mucosa, out through the abdominal wall. This fistula avoided some of the problems of leakage but often made a patient miserable because of the irritation caused by gastric contents on the skin. In order to eliminate this difficulty, Beck [*9*] (1905) and Jianu [*10*] (1912) devised long gastric tubes cut from the greater curvature. These were brought out at a high level and passed behind a skin bridge in order to make a pseudovalve. This method was quite satisfactory although it was somewhat difficult technically since necrosis at the distal end of the tube sometimes led to undesirable results. However, the problem of leakage was diminished greatly by this method.

Finally, Spivack [*11*] (1929) used an ingenious series of sutures to devise a stoma with a true valve which prevented leakage of gastric contents. However, technical problems associated with this operation were much greater, so that operative mortality increased.

When the era of modern surgery of the esophagus was introduced approximately twenty years ago, it soon became apparent that the surgeon had many other operations other than gastrostomy to offer for cancer of the esophagus. Whether these were done as an attempt to cure, such as by a resection of the esophagus, or as a palliative measure in which the esophagus was replaced by a colon transplant, gastrostomy could be avoided in most instances. These direct procedures on the esophagus ultimately have proved far superior, even when only palliative operations are feasible. One of the most important reasons for this conclusion is that regurgitation of saliva due to a completely blocked esophagus cannot be alleviated by

gastrostomy; this is one of the most difficult symptoms to deal with in late cancer of the esophagus. For all of these reasons the so-called "permanent" gastrostomy, in which it is planned that the gastrostomy would be present for several months or until the death of the individual, has been much less popular in the last two decades than it was before. As a consequence, gastrostomy is performed in the Massachusetts General Hospital by one of these methods in only about ten cases a year as the sole operation for cancer of the esophagus; this represents approximately 4 per cent of all the operations performed upon the stomach. However, during exactly this same period, there has been a great increase in interest in the so-called "temporary" gastrostomy that usually is performed in combination with other operations and chiefly as a method of temporary decompression of the gastrointestinal tract. These methods involving the introduction of a catheter into the stomach by some fashion will be discussed in more detail shortly, but first the indications for gastrostomy will be considered more in detail.

There are three indications for gastrostomy. In historic order of their development they are: (1) to provide nutrition, (2) to allow retrograde dilatation of the esophagus, and (3) to provide postoperative decompression of the gastrointestinal tract.

Nutrition may be provided in three particular groups of patients. Gastrostomy has been used most commonly, as a palliative procedure for extensive cancer of the esophagus, larynx or pharynx. Used in this fashion there actually is no indication that it prolongs life [*12*], or contributes in any way toward making the patient more comfortable. It was for this reason that gastrostomies fell into disrepute and were replaced by other procedures on the esophagus whenever possible. At a later date, in a few patients with esophageal obstruction from benign lesions such as lye strictures or stenosis due to peptic ulceration, a gastrostomy was performed and led to indefinite survival. Esophagectomy, carried out a month or so after the burn, may supersede gastrostomy as the treatment of choice.

In other patients severe problems of malnutrition were relieved by means of gastrostomy, so that the patient could be improved before other major operations were performed. Used in this way, gastrostomy usually proved to be more effective than jejunostomy, but its use was more sharply limited since many patients with pyloric obstruction could not be treated in this way. At the present time, in most instances, it is much more logical to pass a small tube down the esophagus and feed the patient by the Baron-Fallis technic rather than by gastrostomy. However, a gastrostomy is still by far the most available procedure in certain instances. For example, a malnourished patient with nearly complete or complete esophageal obstruction from a benign lesion may be prepared by a gastrostomy; furthermore, a gastrostomy is indicated if a suture line leak has developed after an esophagocolic anastomosis in the mediastinum or neck.

Later, gastrostomies were performed to provide an avenue for retrograde dilatation of the cardia when a benign stricture existed in this area. This operation has been superseded by other esophageal surgery that obviated the use of a gastrostomy.

In the third place, gastrostomy has been used to provide postoperative decompression. It is simple to perform and will obviate the use of the Levin tube. Thus, it can be recommended highly in any patient who may be anticipated to have protracted ileus following any laparotomy. It also is invaluable in infants because it avoids the well known hazards of the Levin tube which so often leads to otitis media or other complications of the pharynx and larynx at this age. Also, it is particularly valuable in the aged because it tends to prevent aspiration pneumonia.

Various objections to gastrostomy have arisen, and a consideration of them will point out the importance of certain technical details. In the first place, leakage around a gastrostomy may cause peritonitis and death. The most important feature of prevention of this complication is the careful suture of the stomach to the abdominal wall at the site where the catheter emerges. This may be impossible after a high resection of the stomach and, therefore, other methods of decompression must be used.

Next, the drainage of gastric contents on the skin may be most unpleasant. Many of the obsolete gastrostomies are contraindicated for this reason; furthermore, this problem has been answered brilliantly by the new Barnes-Redo gastrostomy tube which will be described below.

The objection that gastrostomy fails to pro-

vide any real palliation in patients with hopeless cancer has been mentioned previously. Also, a gastrostomy performed prior to an esophageal resection may compromise the length of the stomach so that reconstitution of the gastrointestinal tract may be made much more difficult. For this reason, if a gastrostomy is to be performed in order to improve nutrition prior to an esophageal resection, it should be of the simplest type, preferably made by Stamm's technic, using a Foley catheter.

Finally, if a gastrostomy is made as a decompressive procedure following a gastric resection, pyloroplasty or gastrojejunostomy, there is an impression that it may slow gastric peristalsis and lead to slower function of the gastric anastomosis. While this objection may be true theoretically, it leads to little difficulty in practice since the stomach is decompressed adequately during this time of malfunction.

With these considerations in mind the modern technic for formation of gastrostomy will be considered. At the present time there are only three methods that we have used widely in the past few years that are to be recommended. They include (1) a Stamm type of catheter gastrostomy with a Foley catheter, (2) double jejunostomy for decompression of the postoperative stomach, and (3) the plastic prosthesis for permanent gastrostomy designed by Barnes and Redo.

Simple Stamm jejunostomy, using approximately a No. 26 Foley catheter in adults, is by far the most common. A similar method was used by Horsley [*13*] (1940) and since that time has been modified only by the introduction of the Foley catheter. Popularization of this procedure was speeded by the report of Farris and Smith, and it now is used widely throughout the country. The catheter is anchored in the stomach with two purse-string sutures, and then the gastric wall is sutured to the peritoneum at the site of exit of the catheter. The tube is anchored firmly by a skin suture as well, and then protected by careful flagging because it is possible for the tube to be pulled out if the bag inadvertently is allowed to become decompressed. There are, of course, certain technical problems that can arise from this procedure, such as hemorrhage from a cut mucosal vessel, leakage around the catheter if it is not anchored to the peritoneum, and infection in the abdominal wall. In general terms these problems have proved to be of more theoretical than practical importance, although attention to details of the technic are important to avoid them.

In many instances it is desirable to decompress the stomach, which has been shortened by a high resection, so that it is impossible to appose a decompressing catheter to the peritoneum. A most satisfactory solution of this problem of decompression of the stomach postoperatively was introduced by Allen and Donaldson [*14*], in 1944, with their double jejunostomy technic in which a catheter is led back through the afferent loop of jejunum, through the anastomosis, and into the cardia of the stomach. This provides excellent decompression of the stomach and can be used when other types of gastrostomy are impossible. There has been a long experience with this method in the Massachusetts General Hospital, where approximately 1,000 cases have been carried out with this technic. While it is not necessary to use it for all patients with gastric resection, there are certain instances when it is particularly advisable. These indications include elderly patients who have esophageal reflux or long-standing obstruction, and in whom the problem of aspiration pneumonia is important. It includes patients who are malnourished, those who have secondary gastric operations, and those who are operated on for acute massive hemorrhage. These patients are more subject to complications and a prolonged period of ileus. In these cases the technic has proved to be of inestimable value because, even if stomal obstruction should develop, the surgeon is in command of the situation with catheters. He can keep the remnant of stomach decompressed in a method comfortable for the patient, and he may feed the patient through the lower jejunostomy tube so that no nutrition is lost during this period.

Very few of the objections that have been raised to this method have occurred in practice. A rare case of herniation about the fixed loop has been reported, although it has not been encountered in our hospital. Also, late intestinal obstruction has not been seen from the point of attachment of the small bowel. It has been stated that the presence of a catheter running through an anastomosis will promote stomal obstruction rather than prevent it. Theoretically this could be true, but also the anastomosis theoretically should never be as small in diameter as the catheter that is used.

The final method that is recommended is to

be used for gastrostomies that are to be maintained for several months or for as long as the patient lives. While we have not had any personal experience with this method, the use of the plastic prosthesis developed by Barnes and Redo [*15*] seems to be a very logical answer to this problem. They have contrived a plastic tube that is inserted into the stomach. Then the gastric wall is apposed tightly to the peritoneum by means of a flange. This tube completely prevents any leakage between peritoneum and stomach wall. Furthermore, due to the application of the screw plastic cap, there will be no drainage of gastric contents on the skin. Therefore, the technical objections to nearly all of the other types of permanent gastrostomy are answered by this simple technic.

SUMMARY

The advantages and disadvantages of various types of gastrostomy have been considered. This operation now rarely is performed except as a measure for postoperative decompression of the gastrointestinal tract or to provide nutrition secondary to some complication of operations on the pharynx or esophagus. In the few instances when a permanent gastrostomy is desired for purposes of nutrition, the Barnes Redo plastic tube is recommended. Foley catheter technic is preferred for the temporary gastrostomy to obviate the use of the Levin tube in the presence of an intact stomach. Finally, if a gastric resection has been performed, a double catheter technic (Allen-Donaldson method) is used in instances in which postoperative decompression is deemed wise.

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DISCUSSION

Richard T. Shackelford (Baltimore, Md.): I am not inclined to use gastrostomy as a routine procedure after a gastric operation although I am well aware of the writings and the experience of others. One of my colleagues used a gastrostomy instead of a Levin tube, and a fatal leakage occurred. I have always been perfectly satisfied with the use of plastic Levin tubes and have left them in for various lengths of time up to sixty-six days without any apparent complications.

As to the type of gastrostomy, there is one type that you did not mention that I think has some merit. The trouble with the Janeway or Beck methods is that we have observed sloughs in the long tube that has been created. The one to which I refer is Glassman's gastrostomy. There is only one special precaution that one has to take when doing it. The purse strings go underneath the vessels in the stomach wall so that the blood supply will not be strangulated. It is a very simple gastrostomy which has been rather successful.

We try to avoid palliative gastrostomy for esophageal carcinomas. Someone in our institution found out that our patients did not live any longer or any more comfortably with palliative gastrostomy than they did otherwise.

I think it is an essential procedure in repairing tracheoesophageal fistulas in children. I have not had occasion to repair these often, but the only successful ones that I have performed are the ones which also had a gastrostomy.

John J. Byrne (Boston, Mass.): Dr. Welch, when do you use the double jejunostomy in gastrectomies for benign ulcer?

Claude E. Welch (Boston, Mass.): When this method was invented by Dr. Allen and Dr.

Donaldson, they were so pleased with it that they used it routinely. Dr. Allen continued to use it in every gastrectomy thereafter because there were essentially no problems in the postoperative care, so far as gastric obstruction was concerned.

I would agree in many respects, with Dr. Shackelford, that every additional procedure that one performs, adds a little bit of hazard. Therefore, I have thought that the criteria for using it should be sharpened.

There are certain groups of cases in which its use is quite desirable. Very old patients are often subject to aspiration after operation, particularly if they are depleted, if they have had obstruction for a long period of time or if they have been vomiting so that their esophagus is wide open.

Two other groups of patients also should have this double jejunostomy; those who have been operated on for massive hemorrhage because they are prone to have all sorts of complications, and those patients who have secondary operations upon the stomach.

If one uses a duodenostomy, I think that the double jejunostomy should also be performed because there should be some opportunity to return the duodenal contents.

CHARLES C. LUND (Boston, Mass.): If you perform a gastrectomy on a cirrhotic patient with his tendency to poor wound healing, do you make the jejunostomy through the main wound or do you make a separate wound for it?

CLAUDE E. WELCH: One should always make a separate wound because healing will be complicated if one brings a tube through the primary incision. A simple scalpel is used and a very small stab wound is made two inches lateral to the main incision.

JOHN J. BYRNE: Would you tell us your technic for performing this double jejunostomy?

CLAUDE E. WELCH: Two catgut purse strings in the bowel are used to invert the catheters. The inner purse string is sutured to the catheter so that it is tight. Then the bowel is brought up tight against the abdominal wall and, while the abdomen is still open, skin sutures are put in so that the catheters are sutured tightly in position.

JOHN J. BYRNE: What do you use for jejunostomy feedings?

CLAUDE E. WELCH: In some of these malnourished patients almost anything seems to produce diarrhea, but we have found that most of them can tolerate homogenized milk.

If homogenized milk is well tolerated, the dietary department should blenderize food to be put through the catheter.

Most of the difficulty with the mixtures that have been used for jejunostomy feedings is that they contain large amounts of raw milk or concentrated foods. About 2,500 calories of this blenderized food can be given each day without diarrhea.

CHARLES C. LUND: Some young men start using it a couple of hours after the operation. The time for starting to give food following jejunostomy is no sooner than the time that you would put food in the stomach. Until gas is passed and until there is evidence of intestinal function, nothing should be put in the tube.

Carcinoma of the Stomach

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PESSIMISM has been the prevailing attitude of the medical profession toward carcinoma of the stomach. This has been based in part on the exceedingly small salvage rate reported in some careful studies. One example was the study made in the Los Angeles area some years ago by Guiss [2]. He reported that about 1 per cent of patients with cancer of the stomach lived for five years. Nevertheless, Guiss was careful to stress that the disease was a curable one, and he urged improvements in diagnosis and treatment.

Malignancy of the stomach does present certain well known obstacles which may block effective treatment: (1) symptoms often occur late in the course of the disease and are usually insidious, in contrast to carcinoma of the colon, for example, in which intestinal obstruction may announce the presence of a small lesion that can be treated successfully; (2) lack of objective findings may render diagnosis difficult once the disease is suspected, as compared with the tumor which can be palpated in a cancer of the breast; (3) the proximity of vital structures makes wide excision of an extensive gastric lesion impractical in many instances.

If one adopts a staging system which permits more realistic comparisons with malignant disease in other locations of the body, by allowing for these inherent difficulties, one finds that response to treatment is not at great variance with results following therapy for other malignancies generally regarded as more favorable.

CLASSIFICATION

Some years ago I published a preliminary report [3] describing a classification of carcinoma of the stomach based upon the state of the disease as it existed when the surgeon first treated it. The pathologist was called upon only to determine the presence or absence of malignancy in tissue submitted (the primary lesion, regional nodes resected with the specimen, or a biopsy if no resection was performed). The histologic type of the tumor was not used. The classification depended instead upon two other features: the location of metastasis, if present, and the degree of invasion displayed by the primary tumor.

Three possible situations with respect to metastasis were represented in the classification by the letters A, B, and C. These were defined as follows:

A. No clinical or pathologic evidence of metastasis

B. Involvement of regional nodes only and, hence, presumably susceptible to removal with the primary lesion and possible cure

C. Distant metastasis and, hence, not curable by surgical excision.

Three situations with respect to the degree of invasion shown by the primary tumor were designated by the Roman numerals I, II, and III and defined as follows:

I. Primary lesion confined to inner coats of stomach

II. Primary lesion extends to the serosa but does not involve any adjacent structures

III. Primary lesion involves, by direct extension, neighboring structures (such as colon, pancreas, liver, left gastric lymph nodes).

To account for an additional situation in which the nature of the primary lesion is never explored, the letters NX (not explored) were used. For example, when biopsy of a supraclavicular node shows carcinoma which is presumably metastatic from a gastric neoplasm demonstrable by roentgenogram, exploration of the primary lesion is usually not indicated. The clinical staging will then become C-NX, C meaning that there is distant metastasis, and NX meaning that the primary lesion was not explored.

Application of the Classification. When the two features of the classification are combined, one sees that a carcinoma of the stomach may fall into one of ten stages: A-I, A-II, A-III, B-I, B-II, B-III, C-I, C-II, C-III, and C-NX.

An A-I lesion is the most favorable (this is proved by follow-up studies) since there is no evidence of metastasis and the primary lesion has not extended through the gastric wall. All such lesions can be resected with intent to cure.

Contrariwise, all C lesions (C-I, C-II, C-III, and C-NX) are surgically incurable since distant metastasis cannot be encompassed successfully by surgical intervention. This has proved a useful device for separating out patients who have incurable disease when they first seek treatment. Such patients correspond to patients with stage IV carcinoma of the breast.

A stage B-III lesion is one in which there is involvement of regional nodes with extension of the primary lesion to some neighboring structure. A resection with cure in mind would be possible for some of these lesions if extension involved a nonessential structure such as transverse colon, or the left lobe of the liver, but the outlook obviously would be far worse than that for a patient with a stage A-I lesion. Although the surgeon removes all visible cancer, he will have less confidence that microscopic and invisible islands or extensions have been completely eradicated.

In all stage A-I, A-II, B-I, and B-II lesions, it should be possible to attempt a resection for cure since the primary lesion is confined to the stomach, and metastasis, if present, is local. On the other hand, stage A-III and B-III lesions might or might not be potentially curable depending on the area of extension. Extension to the posterior parietes must be regarded from a practical standpoint as evidence of surgical incurability, as is extension to the structures in the gastrohepatic ligament.

THERAPEUTIC APPROACH

Three cardinal principles have proved their worth in considering therapy for a patient with a real or suspected malignancy of the stomach.

First Principle. Every patient with suspected malignancy of the stomach should have surgical exploration unless there is histologic proof of distant metastasis or the patient is physically unable to withstand an operation. The belief of some physicians that cures of carcinoma of the stomach rarely occur has undoubtedly cost many a patient his chance for cure; a gloomy misinterpretation of physical findings runs a close second. If metastasis to a supraclavicular node is suspected, one should excise it and accept only the pathologist's microscopic description. I have seen a cervical rib assumed to be a rocky hard metastatic node; the patient survives without recurrence of tumor nearly ten years after a gastric resection. The same approach should apply to a suspected Blumer's shelf: Silverman needle biopsy can supply the proof and, if proof is lacking, it is better to explore and find an incurable tumor than to discover at autopsy that the "rectal shelf" was an incarcerated retroverted uterus and the patient's gastric lesion was confined to the stomach.

Similarly, only the surgeon, with the abdomen open and the stomach in his hand, can determine whether or not a carcinoma of the stomach is truly incurable by reason of extension. Radiologist or gastroscopist may give an "informed guess" as to the likelihood of the presence or absence of a potentially curable lesion; however, an "informed guess," if incorrect, is a tragic substitute of a probability for certain knowledge which can be obtained only by operation. Sometimes large and apparently fixed tumors that are easily palpable through the abdominal wall are found at laparotomy to be potentially curable.

The same principle of exploring when in doubt applies to patients in whom symptoms are suggestive but collateral evidence of any gastric lesion is lacking. This prerogative of the surgeon to perform an exploration which may be negative should not be abused, and hospital audits will soon disclose the surgeon who operates without real indications. I have operated in good faith on a number of patients in whom the weight of evidence favored the existence of a malignancy of the stomach, and I can vouch for the fact that I have never received or had a complaint from the patient in whom the exploration disclosed only a normal stomach.

Second Principle. At operation, after a careful search for distant metastasis is negative, excise the primary lesion widely and without biopsy; include the adjacent nonessential structures in an en bloc resection if the primary tumor invades them. Once the abdomen has been opened the first preoccupation of the surgeon should be the search for evidence that the lesion may be incurable. Peritoneal implants and hepatic metastasis should

be biopsied; a frozen section report positive for cancer may stop the operation at that point. Next, the surgeon should seek evidence of local extension rendering the lesion incurable. Extension to the posterior parietes, including periaortic tissues, to the root of the mesocolon with involvement of the superior mesenteric vessels, or into the gastrohepatic ligament is evidence of surgical incurability which the surgeon would do well to heed before he commits himself (and the patient) to a major resection.

If proof of incurability is lacking, the surgeon should embark on a bold plan of resection (without biopsy) including an adequate margin of apparently normal stomach (5 cm. is a minimum) and such additional structures as may be involved. The only extension frequently will be to mesocolon; a segment of mesocolon with the mid-colic vessels should then be removed as a "button" of tissue attached to the stomach. Interference with the blood supply to the transverse colon may not be sufficient to require transverse colectomy, and decision for or against colectomy may be postponed until completion of the gastric resection and anastomosis.

Ideally, together the surgeon and pathologist immediately after resection and before anastomosis should study the resected specimen and by use of the frozen section technic examine tissue from any margin which seems too close to the primary lesion. Cancer in the resected specimen calls for further resection in the area inadequately removed.

This concept of wide resection for cure in no sense advocates routine total gastrectomy.* A total gastrectomy often is necessary but the reason should be for adequate margin from the primary lesion. It has seemed as logical to me to perform a total gastrectomy for a small, circumscribed antral carcinoma as to perform total colectomy for a low rectal cancer, or removal of the entire scalp for a cancer of the forehead! Results justify conservatism. An argument favoring "routine total gastrectomy" has been the study of McNeer and associates [5]. They found recurrence of cancer in the gastric remnant in 50 per cent of ninety-two autopsies performed in the New York and Brooklyn area after death from cancer of the stomach, and following subtotal gastrectomy. If a pathologist checks the lines of resection with the surgeon *before* the operation is concluded, and the surgeon is willing to resect further if the margin is skimpy or contains tumor, recurrence in the gastric remnant will be very rare.

Similarly, the concept of wide resection for cure does not advocate the ultraradical lymphadectomy suggested by Arhelger, Lober, and Wangensteen [1]. It is appropriate that these investigators continue to ascertain whether advantage will accrue to the patient from attempts to eradicate the lymph node areas draining the stomach. The rest of us, however, should await the results of their study, and should not follow this suggestion before its superiority is clearly proved. Increased morbidity and mortality are certain to follow extended surgery about the stomach. My own guess is that the results will not show any improvement over less radical surgery, *provided local margin from the primary tumor is adequate and possible seeding of the tumor by biopsy or by cutting through tumor is avoided!*

Third Principle. If the lesion is incurable by reason of distant metastasis or local extension, one should think carefully before performing a palliative resection. Mortality is high and palliation often fails. Results of palliative surgery quoted in the latter part of this paper are not brilliant. The symptoms from which the patient suffers should be weighed carefully. Obstruction may well call for an attempt at some palliative procedure—a resection or bypass—but simple blood loss anemia with minimal gastric symptoms is almost always better handled by judicious use of blood transfusions rather than attempts to eradicate an incurable primary lesion. In particular, a palliative procedure involving a total or nearly total gastrectomy should be shunned. These patients rarely live long enough to recognize any improvement over the preoperative status.

Gastric Ulcers. No discussion of the therapeutic approach to patients with suspected malignancy of the stomach would be complete without considering the problem raised by the patient who has a gastric ulcer. Surgeons, in general, are aggressive in urging operation, whereas internists tend to be overly conservative. A sensible middle ground should be possible. Not

* Longmire [4] first reported a large series of cases of total gastrectomy employed for nearly every patient with carcinoma of the stomach (twenty of twenty-five). Although he pointed out the possible advantages in wider removal of lymph node bearing areas even with small lesions, he was circumspect about advising it as a routine. Most surgeons employ it only as advised here, to provide a necessary margin from the primary lesion.

all patients with a gastric ulcer will require operation. In this institution more than 50 per cent are treated medically, with a very low rate of error. However, the surgeon and internist should follow the patient together as a team. Prompt operation should be advised if (1) there is histamine achlorhydria, (2) the ulcer appears malignant by radiologic criteria, (3) cytologic studies show tumor cells in the gastric juice, (4) the ulcer fails to heal completely in four to six weeks, (5) the ulcer recurs after healing, or (6) the usual indications for ulcer surgery exist (for example, persistent pain, bleeding or obstruction).

If operation is advised, both surgeon and patient may take comfort from the fact that the prognosis is approximately four times as good as in those patients whose preoperative diagnosis is clearly gastric malignancy [6].

RESULTS OF TREATMENT AND DEFINITIONS

Certain expressions in the literature should be clarified in any analysis of malignancy of the stomach in which statistics are used.

"Operable" Lesions and "Operability Rates." The expression "operable" has come to be synonymous with the idea that the lesion is curable as far as we can tell without operating. Improvement in "operability rate" is assumed to mean a more aggressive surgical attitude and, hence, to represent progress. I believe the expression is a poor one and essentially without meaning, since the decision to perform surgical exploration cannot be reduced to exact criteria, and reliable comparisons between surgeons or institutions are therefore impossible. The expression is not used in this article.

"Resectable" Lesions and "Resectability Rates." Unless the term "resectable" is qualified, it is without meaning as it relates to the treatment of gastric malignancy. The term should always be qualified, as it is in this paper: (1) "*resection for cure*" (or "curative resection") meaning that all tumor has been removed at surgery as far as the surgeon can tell, or (2) "*palliative resection,*" meaning that the tumor remains in the patient. A failure thus to distinguish becomes particularly troublesome to anyone attempting to compare five-year survivals of "resection" for carcinoma of the stomach.

"Cancer of the Stomach." Strictly, this means epithelial malignant neoplasm (carcinoma) but it has come to mean any malignancy of the stomach. In this paper carcinoma is distinguished from lymphoma and sarcoma, and I have tried to avoid the word "cancer" altogether.

TABLE 1
TREATMENT AND MORTALITY*

Type of Treatment	No. of Patients	Mortality†
Resection for cure	125	9 (7.2)
Palliative resection	31	6 (19.3)
Biopsy only	98	3 (3.1)
Total	254	18 (7.1)

* These statistics concern a personal series of patients treated between January 1950 and March 1960.

† Figures refer to deaths during hospitalization, and figures in parentheses refer to percentages of deaths.

RESULTS IN A PERSONAL SERIES

Between January 1950 and March 1960 I operated upon 254 patients with carcinoma of the stomach. The follow-up rate is 100 per cent. Twenty-four patients with lymphoma and sarcoma are excluded although clinical management, clinical staging, and results are comparable to the much larger series of carcinoma. Incurable disease was found in 129 patients at the time of operation; a resection for cure was performed in 125 patients, about 50 per cent of the series. Hospital mortality is shown in Table 1.

Resection for Cure

Hospital Mortality. One of the nine patients who died in the hospital (among the 125 resections for cure) was a man seventy-nine years of age. His lesion was staged as A-II, and he died following a perforation of his tumor. A first stage operation (splenectomy for better exposure of a high lesion) had been necessary because his condition became poor during surgery. An anastomotic leak played some role in the death of six of the remaining patients; these were extensive lesions requiring large resections in debilitated patients. Total gastrectomy or esophagogastrectomy was performed in four of the six, and in another colectomy with gastrectomy was used. One patient in this group of six died of an anastomotic leak following simple subtotal gastrectomy. One patient died of acute pancreatic necrosis, and one of disseminated staphylococcal infection.

Although the hospital mortality is an impor-

TABLE II
STAGE AND POSTOPERATIVE STATUS*

Stage	Total	Mortality (Carcinoma)		Living and Well	Mortality (Other Disease)		Median Duration of Life† (mo.)
		Total	After 5 Yr.		After 5 Yr.	Less than 5 Yr.	
A-I	10	2	1	8	...	...	63
A-II	15	9	1	4	1	1	19
A-III	12	5	1	7	...	...	21
	37	16	3	19	1	1	
B-I	2	1	...	1	...	...	34
B-II	22	19	...	3	...	...	14
B-III	10	8	...	2	...	...	18
	34	28	...	6	...	...	
Total	71	44	3	25	1	1	

* Figures refer to the status five years postoperatively of seventy-one patients who survived definitive resection prior to January 1955.

† Statistics concern only those patients who died of carcinoma. Time is measured in months.

TABLE III
STAGE AND COMPARISON OF SURVIVAL RATES

Stage	Three Year Survival		Five Year Survival	
	No. of Patients*	No. of Survivors†	No. of Patients*‡	No. of Survivors†
A-I	11	9	10	8
A-II	22	12	14	5
A-III	12	7	12	7
	45	28 (62.2)	36	20 (55.5)
B-I	3	2	2	1
B-II	28	5	22	3
B-III	14	2	10	2
	45	9 (20.0)	34	6 (17.6)
Total	90‡	37 (41.1)	70‡	26 (37.1)

* Those who survived definitive resection.

† Figures in parentheses indicate percentages of survival.

‡ This excludes one death at seventeen months from intercurrent disease.

tant feature of treatment for carcinoma of the stomach, it is not a measure of the efficiency of the operation *per se* in curing cancer. In this study the mortality is noted and regretted, but the fatal cases are then excluded from consideration of five year survival rates.

Two additional patients died suddenly at home within ten weeks after operation. They have been excluded since the deaths were presumed to be due to something other than cancer. Thus, resection for cure was performed on 125 patients; nine of these died during hospitalization. If the two sudden deaths at home and the hospital deaths are subtracted from the total of 125 patients, 114 survived resection.

As a basis for determining rates for five year survival, it is noted that seventy-one of the 114 patients who survived had their operations prior to January 1955. As a basis for determining rates for three year survival, it is noted that ninety of the patients were operated upon before January 1957.

Staging and Survival. Table II shows the current status of the seventy-one survivors of curative resection performed prior to January 1955. They are analyzed according to the clinical staging at the time of operation. Of special interest is the fact that eight of ten patients staged as A-I (no metastasis, primary lesion confined to inner coats of stomach) are living and well. By way of contrast, only two of ten patients with B-III lesions (regional metastasis, primary tumor invades adjacent structure) are living and well.

The effect of lymph node involvement on prognosis is made clear when all A lesions (A-I, A-II, and A-III) are compared as a group with all B lesions (B-I, B-II, and B-III); five year survival for the A group is 55 per cent, for the B group 18 per cent.

One other aspect of staging and prognosis is that, stage for stage, patients with A lesions ultimately dying of cancer live longer than those with B lesions.

On the other hand, it is of interest that there does not seem to be much distinction in survival between patients in the A-II group and patients in the A-III group, or between patients in the B-II group and patients in the B-III group. Prognosis is related to metastasis or its absence rather than extension of the primary tumor, provided that adequate margin about the primary lesions is obtained.

Table III compares three year and five year survivals, stage by stage. Qualitative differences remain the same, but it is clear that a number of patients surviving for three years will ultimately die of their disease.

TABLE IV
STAGE AND TREATMENT*

Stage	No. of Patients	Method of Treatment				
		Partial Gastrectomy	Total Gastrectomy	Esophago-gastrectomy	Partial Gastrectomy and Other†	Other
A-I	14	14	...	...	...	...
A-II	29	25	3	...	...	1
A-III	16	8	4	1	3	...
B-I	5	5	...	...	...	...
B-II	37	19	13	5	...	...
B-III	24	7	8	4	5	...
Total	125 (9)	78 (3)	28 (3)	10 (1)	8 (1)	1 (1)

* Figures in parentheses refer to the number of deaths in each group.
† Refers to resection of multiple organs.

Type of Procedure and Survival. Table IV shows the type of procedures employed in attempting cure in the 125 patients who underwent curative resection. It is clear that the more complicated procedures are required for the more extensive lesions. If one groups together stages A-I, A-II and B-I lesions, thirty-one of thirty-five patients required only a simple partial gastrectomy. Half of the sixteen A-III lesions required a more complicated operation; thirty-five of sixty-one patients with B-II or B-III lesions had total gastrectomy, esophagogastrectomy or multiple organ resections. As one would expect, the mortality rises with more extensive operations: 4 per cent for partial gastrectomy, 11 per cent for resection involving the esophagus (total gastrectomy and esophagogastrectomy).

Although the series is too small to justify percentages, Table V does demonstrate that there are five year survivals following both simple and extended operations. In a sense this justifies the judicious use of each.

Lesions Incurable at Operation

Palliative Procedures. Table VI speaks for itself. At least in my hands, palliation often fails in its purpose. One-third of the thirty-one patients in whom some form of palliation was attempted were dead within a month. Patients whose obstruction was not relieved are not shown in the statistics. At present, I rarely perform a resection if I must cut through tumor to do so. Obstruction remains the primary indication for attempting palliation.

Biopsy Only. The fate of patients who have no procedure beyond biopsy is clearly shown in Table VII. In the C-NX group of seventeen, five patients had positive biopsy of a supraclavicular node, four had Silverman needle perineal or transvaginal biopsies, six had a limited laparotomy, and one each had a skin biopsy and paracentesis which were positive for tumor cells. The longest period of survival in this group is eleven months and three weeks. There is a slight increase in longevity if the reason for incurability was extension of the primary lesion

TABLE V
TREATMENT AND FIVE YEAR SURVIVAL*

Type of Treatment	No. of Patients	Living and Well†
Partial gastrectomy	45	19 (42)
Total gastrectomy	15	5 (33)
Esophagogastrectomy	4	.....
Partial gastrectomy and multiple organs	6	2 (33)
Total	70	26 (37)

* Figures include patients who survived curative resection performed prior to January 1955.
† Statistics concern patients who are living and well five years after treatment. Parentheses indicate percentages.

TABLE VI
PALLIATIVE TREATMENT AND SURVIVAL

Type of Treatment	No. of Patients	Mortality		Survival*		
		During Hospitalization	Within 30 Days	No. of Patients	Median†	Longest†
Resection	14	4	2	8	7	23
Exclusion or excision	5	0	0	5	5	5
Bypass or gastrostomy	12	2	3	7	4	8
Total	31	6	5	20		

* Figures include patients who survived more that one month.
† Numbers represent months.

(A-III and B-III) but not sufficient increase to warrant any optimism.

Although a C-I lesion (distant metastasis, primary lesion confined to the inner coats of the stomach) is a theoretical possibility, it is noteworthy that none was found among the 254 cases reported herein. It would seem that in carcinoma of the stomach, at least, the primary lesion must exhibit a certain degree of aggressiveness before distant metastasis becomes evident.

SUMMARY

Guarded optimism regarding treatment of carcinoma of the stomach is justified. Results of a personal series of 254 patients staged according to a simple clinical classification is presented. Eight of ten patients with A-I lesions (no metastasis, primary lesion confined to the inner coats of the stomach) are alive and well five or more years after surviving definitive resection. Fifty-five per cent of all patients who had no involved nodes are alive and well five years or more after resection. On the other hand, none of ninety-six patients with C lesions (distant metastasis) in whom a biopsy only was performed was alive one year after operation.

Three principles governing treatment are emphasized:

1. With rare exceptions the patient with suspected gastric malignancy should have surgical exploration.

2. At operation, if the lesion is potentially curable, the surgeon's principal objective is wide excision of the *primary lesion*, without biopsy, including *en bloc* excision of any involved adjacent nonessential structures.

3. If the lesion is incurable, palliative procedures should be used with restraint in view of the high mortality, morbidity and frequent failure of palliation. Obstruction will be the chief indication for attempted palliation.

TABLE VII
SURVIVAL AND STAGE*

Stage	Survival Time‡					Longest Survival (mo.)
	No. of Survivals	1 Mo.	3 Mo.	6 Mo.	9 Mo.	
C-NX	17	11	8	2	1	9
C-III	47	40	18	6	2	11¾
C-II	13	10	3	...	...	6
	77	61	29	8 (14)§	3 (4)	
B-III	15	13	7	3	1	10
A-III	4	4	3	2	1	9
	19	17	10	5 (26)	2 (11)	
Total	96†	88	39	13 (14)	5 (5)	

* Figures are for patients who had incurable gastric carcinoma. Only biopsy was performed.
† Two patients who are still living six months or less after operation are excluded.
‡ Numbers in the columns refer to number of patients living at the indicated number of months.
§ Parentheses refer to percentages.

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DISCUSSION

Richard T. Shackelford (Baltimore, Md.) One of the contraindications for gastrectomy which Dr. Hoerr mentioned was distant metastasis. I will agree to a considerable degree, but I think there are instances where this is not so. I know of seven cases that Dr. Murray Fisher reported in which the patients had solitary metastases to the lung and are now surviving five years after a gastrectomy was performed and the solitary metastasis was removed.

I do believe in palliative resections if the tumor is resectable and, by "resectable," I mean that one believes that the primary growth can be removed. The patient may have a metastasis which cannot be treated surgically in the liver or at another location, but I think that the patient is more comfortable with his primary growth removed.

George L. Jordan, Jr. (Houston, Texas): I agree wholeheartedly with Dr. Hoerr on virtually everything he said. It is my opinion that there is nothing to be gained by a routine splenectomy since it does not increase the survival rate. I think it does significantly increase the risk to the patient.

We have not had as many leaks from the anastomosis as Dr. Hoerr mentioned, but it has become apparent to us that those we have had have occurred in the very high resections when the spleen was removed, therefore, the gastric stump was relatively devascularized. It has also occurred in the elderly patient in whom blood supply to the stomach is poor.

John J. Byrne (Boston, Mass.): Is a gastroenterostomy ever of value in an obstructing carcinoma of the stomach? We occasionally use them but they seldom function as a gastroenterostomy.

Stanley O. Hoerr (Cleveland, Ohio): I think that Dr. Shackelford's points are well taken about the place of resection in the presence of distant metastasis. I was not aware of the situation previously described in which resection of the isolated pulmonary metastasis plus the primary tumor in the stomach resulted in cure. I am very much interested in it. I am sure that the approach is absolutely correct if one can remove a metastasis of this sort and it is the only one.

I do not object to resection when one thinks that all of the primary tumor can be removed. In fact, I think I said that one should think about it carefully. I did not say that it should never be done.

The thing that has bothered me in performing a splenectomy is that the splenic vessels go right on toward the aorta. Unless one plans to resect them, it does not seem logical just to remove the spleen. If they are resected, the surgical risk is substantially increased.

Perhaps I should defend myself concerning the anastomotic leaks. I think we advance only by looking at things honestly, even if we do not like what we see.

Four of the anastomotic leaks occurred when the esophagus was involved. One of them was due to a technical situation in the operating room when I was performing combined transverse colectomy with a partial gastrectomy. The first assistant was retracting upward on the stomach so sharply that he injured the blood supply.

This was not his fault. It was my fault. I always tell those who are helping me that there can never be any evasion of responsibility on the part of the operating surgeon. If one of his assistants makes a mistake, it is a mistake on the part of the operating surgeon who trusted the assistant with that particular part of the operation.

Primary Sarcomas of the Stomach

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THIS paper is an analysis of twenty-eight cases of primary sarcoma of the stomach in patients treated at the Johns Hopkins Hospital by surgical exploration, all of whom were followed up. The series includes only those patients from whom tissue taken from the gastric lesion has been reviewed and identified as sarcoma. This review revealed that seven previously diagnosed sarcomas were undifferentiated carcinomas and one gastric biopsy initially reported as lymphosarcoma was demonstrated by autopsy to be chronic gastritis. These eight cases were excluded from this series. No review of the carcinomas of the stomach was made in search of mistakenly diagnosed sarcomas.

Other cases of verified sarcoma were rejected if the lesion was not primary in the stomach or the documentation was equivocal.

These twenty-eight gastric sarcomas represent a number too small for statistical analysis but large enough to provide an experience that permits some inferences.

There were thirteen reticulum cell sarcomas (eight men, five women) (Fig. 1A and B), thirteen leiomyosarcomas (eight men, five women) (Fig. 1D) and two lymphosarcomas both in men. (Fig. 1C.) The age of the patients afflicted with each one of these three types of sarcoma is listed in Table I.

TABLE I
GASTRIC SARCOMA AGE DISTRIBUTION

Age Group (yr.)	Reticulum Cell (no.)	Leiomyosarcoma (no.)	Lympho-sarcoma (no.)
10–19	1 (17 yr.)	1 (19 yr.)	0
20–29	1	0	0
30–39	2	2	1
40–49	2	0	0
50–59	5	5	1
60–69	0	3	0
70–79	2 (each 70 yr.)	2 (70 and 72 yr.)	0
Total..	13	13	2

The reticulum cell sarcomas and the leiomyosarcomas occurred with parallel frequency in patients of similar age and sex. The youngest patient with either tumor was in the late teens and the oldest in the early seventies; the largest number was in the sixth decade of life. Each of these two types of sarcoma occurred in eight males and five females. The two patients with lymphosarcoma were men, thirty-eight and fifty-three years of age.

CLINICAL PICTURE

There were no characteristic nor constantly occurring symptoms or signs. Most often they suggested a peptic ulcer or gastric carcinoma. A few patients complained only of fatigue and weakness without localizing symptoms or signs. Two were asymptomatic despite the unexpected discovery of a very large tumor in one. One febrile patient with ulcerated reticulum cell sarcoma had a positive blood culture and was treated for subacute bacterial endocarditis until her large tumor was discovered and removed. Promptly thereafter her temperature returned to normal and she appears to be in good health at present.

The presenting symptoms and signs of the patients in this series are listed in the order of their frequency of occurrence in Table II.

Abdominal pain or discomfort, weight loss, anemia, melena and vomiting were the five symptoms that occurred most frequently, but none occurred in all the patients. The incidence

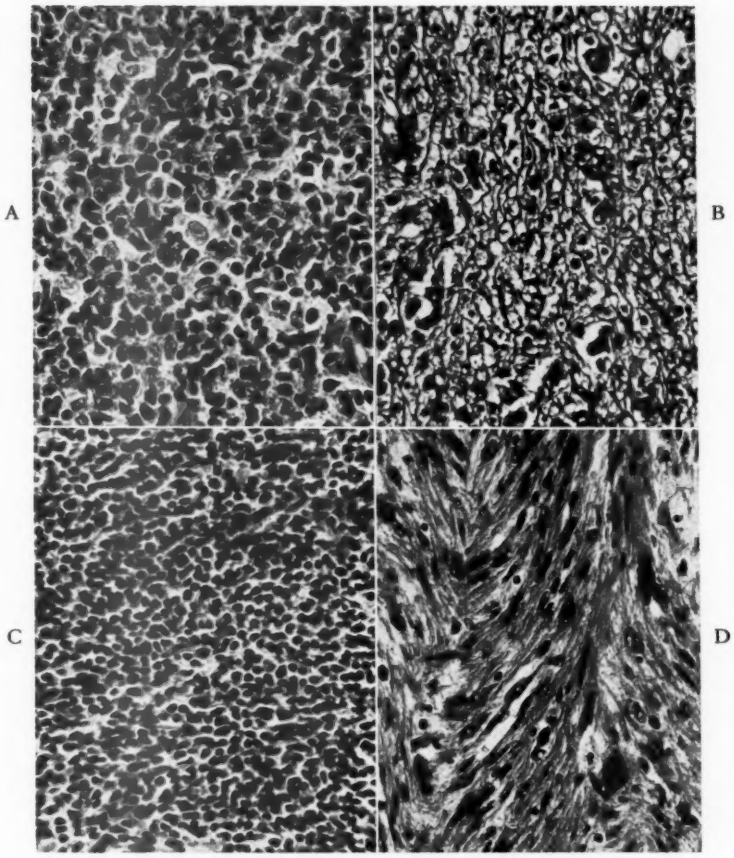


FIG. 1. A, reticulum cell sarcoma with pleomorphic cells, pale cytoplasm and irregular nuclei containing variable amounts of prominent, often clumped chromatin; (hematoxylin and eosin, × 600). B, reticulum cell sarcoma with delicate, interlacing reticulum separating cells; (Gomori's reticulum stain, × 600). C, lymphosarcoma with prominent relatively uniform hyperchromatic nuclei and sparse cytoplasm; (hematoxylin and eosin, × 600). D, leiomyosarcoma with interlacing cell bundles. Cells are elongated and contain pleomorphic nuclei. Mitoses are prominent; (hematoxylin and eosin, × 400).

of these symptoms did not differ significantly in the three different types of sarcoma. A palpable mass was present in only five of the twenty-eight cases and four of these masses were leiomyosarcomas, the type which produced the largest of the tumors. Achlorhydria was present in four cases, all of which were reticulum cell sarcomas, but some other patients with this type of tumor had normal amounts of free acid in their gastric analyses. Generalized lymph gland enlargement was noted in three of the patients with reticulum cell sarcomas.

The most helpful and reliable diagnostic procedure was a roentgenographic study of the stomach in which barium was used as the contrast medium. It ultimately demonstrated the presence of a gastric lesion in all of the twenty-three cases in which it was employed. In eighteen patients this demonstration occurred at the first such examination but in five a lesion was not revealed the first time. In one of these five patients three examinations at brief intervals of time were unrevealing before a fourth attempt demonstrated a suspected lesion which was found at operation to be too extensive for its removal. The specific nature

TABLE II
SYMPTOMS AND SIGNS

Symptoms	Reticulum Cell Sarcoma	Lymphosarcoma	Leiomyosarcoma	Total
Abdominal pain or discomfort	8	1	8	17
Weight loss	9 (15–30 lb.)	1 (50 lb.)	5 (10–30 lb.)	15
Anemia	6	2	7	15
Melena	5	1	6	12
Vomiting with or without hematemesis	4	1	3	8
Palpable mass	1	0	4	5
Fever	2	0	2	4
Achlorhydria	4	0	0	4
General lymph gland enlargement	3	0	0	3

of the lesion was correctly surmised in three cases of leiomyosarcoma. Preoperative x-ray examination was omitted in five cases because of active gastric bleeding which made prompt operation more desirable.

Gastroscopy was employed preoperatively in six cases. A lesion was seen and biopsies performed in only two. The biopsy correctly identified the reticulum cell sarcoma but demonstrated only normal mucosa over a leiomyosarcoma. In the remaining four cases the lesion was not visualized although its presence had already been demonstrated by roentgenograms. In no instance did gastroscopy discover a lesion previously missed by roentgenographic study.

RETICULUM CELL SARCOMAS

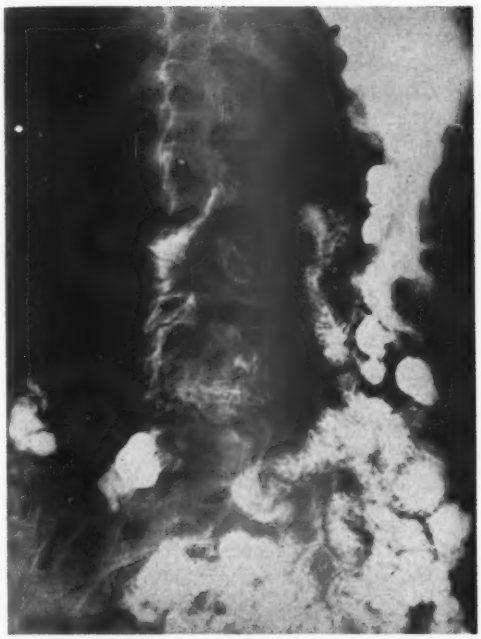
Reticulum cell sarcoma was identified microscopically by cells of variable size that contain relatively prominent cytoplasm and pleomorphic nuclei with prominent nucleoli and chromatin clumps. (Fig. 1A.) With Gomori's reticulum stain, tumor cells are surrounded by delicate, interlacing reticulum fibers. (Fig. 1B.) Reticulum staining was helpful in distinguishing reticulum cell sarcoma from undifferentiated carcinoma; in the latter the reticulum pattern is characteristically distorted and disarrayed.

Two patients had tumors which were found to be nonresectable when explored surgically. Biopsies were performed in both and the abdomen closed without further manipulation. Postoperatively one patient was treated with x-ray therapy and the other with nitrogen mustard. Each patient died one month after exploration.

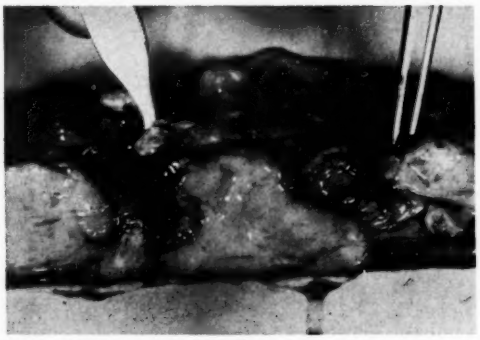
Eleven patients had their tumors resected. In four of these a partial gastrectomy was performed and no postoperative supplemental therapy was employed. Two died of sarcoma after operation three months and twenty-eight months, respectively. One was operated upon too recently to evaluate the result. (Fig. 2A, B, C and D.) However, the fourth is alive and well nine years later as confirmed by a recent physical and radiographic examination. He was fifty-four years old when operated upon. A partial gastrectomy was performed to remove a baseball-sized reticulum cell sarcoma involving the distal two-thirds of the stomach. The tumor contained a deep ulcer crater but did not invade any adjacent organs nor were any involved lymph nodes found either during the operation or in the pathologic examination of the specimen.

Two additional patients had tumors extensive enough to require total gastrectomy for their removal. Both died, one in the immediate postoperative period and the other lived comfortably for two and three-fourths years before dying with tumor.

Four patients were treated by partial gastrectomy followed by postoperative radiation therapy. Two of these died with a recurrence six months after their operation. However, the other two patients had favorable results. One of these was a thirty-nine year old man in whom an x-ray film taken elsewhere showed such extensive involvement of the stomach with tumor that he was considered inoperable. He came to the Johns Hopkins where the greater part of the stomach that contained the tumor as well as the invaded transverse colon were resected. Some of the regional lymph nodes removed with the specimen also contained tumor. Postopera-

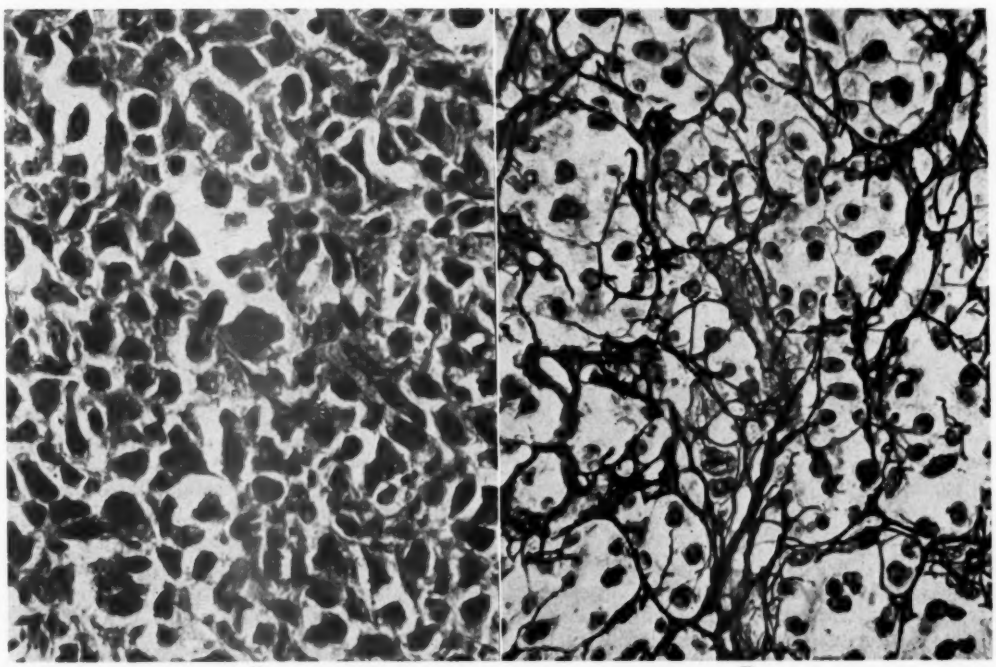


A



B

FIG. 2. Reticulum cell sarcoma in seventeen year old girl. A, preoperative x-ray. B, cut section of gross specimen.



C D

FIG. 2. C, photomicrograph of pleomorphic reticulum cells; (hematoxylin and eosin, × 600). D, photomicrograph showing interlacing reticulum fibers surrounding cells; (Gomori's reticulum stain, × 600).

A

FIG. 3. A, lymphosarcoma; lateral view of preoperative x-ray.

tively his treatment was supplemented by a course of x-ray therapy. He is living and well six and one-half years after his operation.

The other favorable result following partial gastrectomy and postoperative radiation therapy was a forty-nine year old man with a baseball-sized tumor (Fig. 1A and B) involving the middle third of the stomach. The tumor contained an ulcer crater. No tumor-containing nodes were found either at operation or in the removed specimen. Four years after his operation and x-ray therapy he died from a coronary occlusion. An autopsy was performed and no evidence of recurrent or residual tumor was found.

The final case in this group of reticulum cell sarcomas was a thirty-seven year old man. Biopsy of a lymph node had been diagnosed as Hodgkin's disease and palliation was satisfactorily obtained with eleven courses of x-ray therapy and/or nitrogen mustard given on repeated hospital admissions over a period of five years. After this time gastric obstruction developed and required an operation for its relief. The tumor was found to involve the entire stomach and regional lymph nodes. A total gastrectomy was performed. He died of recurrent tumor six months later despite a repeated course with x-ray therapy and nitrogen mustard.

The presence or absence of tumor-containing lymph nodes influences the results in resection of reticulum cell sarcoma. Only three of the eleven resected cases of reticulum cell sarcoma had positive nodes. Of these, one patient is living and well six and one-half years after excision and postoperative x-ray therapy. Another treated in the same way has survived too short a period for the result to be evaluated. The third patient died six months after operation of recurrent tumor.

Of the eight patients in which no tumor-containing lymph nodes were found, one is living and well nine years later and one died of a coronary occlusion four years after operation and autopsy demonstrated no tumor. The remainder died of recurrent tumor except the one who died in the immediate postoperative period.

LYMPHOSARCOMAS

Microscopically, these lymphosarcomas consisted of cells with small, basophilic, relatively uniform nuclei surrounded by scant cytoplasm (Fig. 1C) closely resembling lymphocytes.

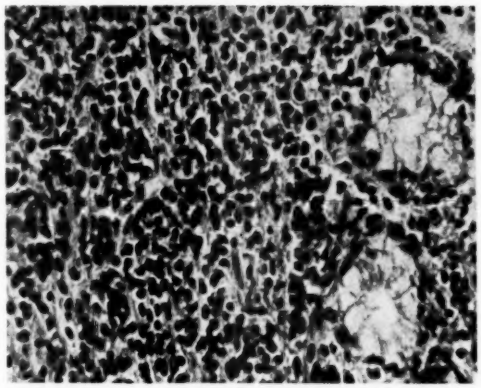
There were only two patients with primary lymphosarcomas of the stomach in this series. Both were men and both had gastric tumors that were too extensive to be resected. They are still living but neither is free of his disease.

One was a thirty-eight year old male patient whose gastric tumor was explored and a biopsy performed in 1948. The tumor was an unresectable lymphosarcoma. The abdominal incision was closed. He was treated postoperatively by a course of x-ray therapy with beneficial results. He returned to his job as a mechanic. In 1957 he underwent an exploratory thoracotomy for a lung lesion that was suspected of being malignant. It was found to be a localized cyst containing fluid. No evidence of tumor within the thorax was found during a thorough exploration nor in a biopsy of the mediastinal nodes. In 1958 his gastric symptoms of indigestion, vomiting and weight loss returned and he was treated with another course of radiation therapy followed later by nitrogen mustard chemotherapy. The treatment was temporarily effective. The same

regression and improvement following the same treatment occurred in June 1959. At present, twelve years after his initial exploration, he is living but is underweight and shows evidence of persistence of his disease.

The other patient with a lymphosarcoma was fifty-three years old when an exploratory laparotomy revealed an extensive and unresectable gastric tumor. (Fig. 3A.) A biopsy was performed and the abdomen was closed. The microscopic slide demonstrated a lymphosarcoma. (Fig. 3B.)

No treatment of any kind has been tried but he is being seen at regular intervals by a physician. Lymphoma cutis has developed and the patient is not well but he continues doing light farm work twenty months after his exploratory operation.



B

FIG. 3. B, photomicrograph showing hyperchromatic, slightly variable lymphocytic nuclei and sparse cytoplasm; (hematoxylin and eosin × 600).

LEIOMYOSARCOMAS

Histologically, these tumors were composed of elongated cells arranged in interlacing bundles. The nuclei were centrally located, often prominently hyperchromatic and occasionally pleomorphic. Typical and atypical mitotic cells were found. (Fig. 1D.)

There were thirteen patients with tumors of this type in the series. Eight were males and five were females. In two patients leiomyosarcomas of the stomach were found at operation to be nonresectable. A biopsy of the tumor was obtained and the abdominal wound was closed without further surgical manipulation. One of these patients was treated with postoperative x-ray therapy without any benefit and death from the tumor occurred one month after the operation. The other patient received no postoperative treatment and died five months later with tumor.

Eleven patients had their tumor removed by a resection of part or all of the stomach. The only patient treated by a local excision of the tumor with a surrounding margin of normal gastric tissue was a sixty-seven year old man who had an emergency operation for massive upper gastrointestinal hemorrhage. A golf ball-sized leiomyosarcoma of the stomach was found to be the cause of the bleeding and was locally excised. Microscopic examination of the specimen revealed no evidence of venous invasion by the tumor. He has remained living and well for ten years since his operation, and a recent physical and roentgenologic examination revealed no evidence of recurrence.

Eight of the patients had their tumors removed by a partial gastrectomy. Three are still living. One of these is a thirty-eight year old man who was asymptomatic but underwent a routine physical examination, during which a roentgenographic study revealed a gastric lesion. At operation a golf ball-sized leiomyosarcoma was found and removed by a partial gastrectomy. Microscopic examination of the specimen revealed no evidence of venous invasion by the tumor. He is still living and well seven years after his operation. Another of these patients is still living in apparent good health but only four months have elapsed since his operation. The third living patient was nineteen years old when she was operated upon elsewhere in 1952 for upper gastrointestinal bleeding. A small gastric tumor was found to be the source of the bleeding and a biopsy and frozen section study was reported as a leiomyoma. The tumor was locally excised and the abdomen closed. A few days later study of the permanent microscopic sections demonstrated it to be a leiomyosarcoma. She was transferred to the Johns Hopkins Hospital where a month after her first operation she was reoperated upon. No tumor could be seen or felt at the site of the previous excision; but because of the narrow margin of normal tissue reported to have been excised with the original tumor, a wider excision by means of a partial gastrectomy was performed. This was a fortunate decision because microscopic study of the removed specimen revealed residual tumor cells

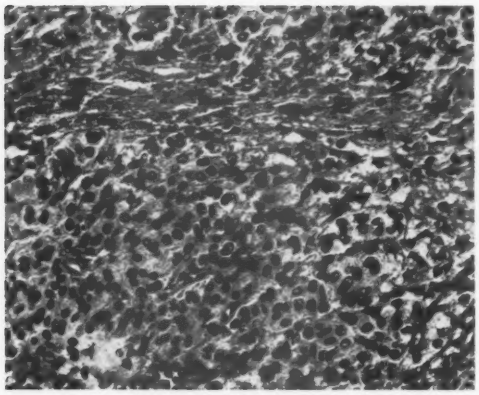


FIG. 4. Photomicrograph of focus of residual leiomyosarcoma; (hematoxylin and eosin × 400).

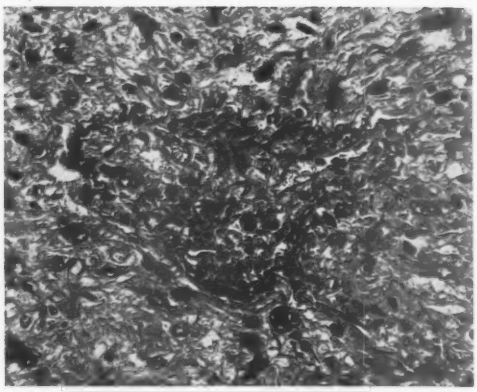


FIG. 5. Photomicrograph of venous invasion by leiomyosarcoma. The disarrayed focally destroyed black elastic tissue delineates tumor within the vein from that surrounding the blood vessel; (Verhoeff-Van Gieson, × 400).

at the site of the original excision. This remaining tumor is insufficient to evaluate the presence of venous invasion. (Fig. 4.) The patient remained well for six years before having recurrences of her tumor which was excised in another city in 1957, again in 1958 and again in 1959. At present she is still living nine years after her original operation but the prognosis is uncertain.

However, two seventy year old women whose leiomyosarcomas of the stomach were removed by partial gastrectomy lived in freedom from their tumor for six and three years, respectively; both died of cerebrovascular accidents. Autopsies revealed no evidence of residual or metastatic tumor.

The remaining three patients treated by partial gastrectomy have died. One was a postoperative death. In the other two the tumor had invaded adjacent structures which had to be removed along with part of the stomach. One of these was a sixty year old man who had been explored and declared to have an inoperable neurofibrosarcoma at another institution. He came to the Johns Hopkins where he was re-explored and the tumor with 75 per cent of the stomach and the invaded transverse colon were resected. Pathologic examination of the specimen demonstrated the tumor to be a leiomyosarcoma with an ulcer crater. (Fig. 1D.) He lived comfortably for two years before a fatal recurrence. The other patient with a multiple organ resection also lived in comfort for two years before his fatal recurrence.

Both patients treated by a total gastrectomy have died with recurrence of their tumor. One of these lived comfortably for three and two-third years after his operation and the other was palliated for six months. The operation seemed worth while for each of these patients.

Lymph node involvement by leiomyosarcoma of the stomach was remarkably uncommon in this series. Positive lymph node involvement was found at operation and/or in the resected specimen in only one of the eleven patients with resectable tumors. In this one case there were also metastases within the spleen. The patient died of recurrence six months after the operation.

No tumor was found in the lymph nodes of ten patients and in seven of these there was, in addition, no invasion of adjacent structures or distant metastases. Of these seven, only one has died with a recurrent tumor and his death occurred three and two-third years after his operation. Another died postoperatively. Two others died of unrelated conditions six and three years, respectively, after their operation but in both cases an autopsy revealed no evidence of recurrence of their tumors. Two of these seven patients are living and well without evidence of recurrence revealed by physical and radiographic studies ten and seven years, respectively, after their operation. The seventh patient lived in good health for six years but has had three separate recurrences excised, one in each of the last three years. She is still living nine years after her original operation but the prognosis is uncertain.

In three of the ten patients with no lymph node involvement the tumor had invaded adjacent structures which were removed with the specimen. Two of these died of recurrent tumor, each two years after the operation. One is living in apparent good health for the brief period of only four months after his resection.

Probably the most interesting fact derived from this study was the prognostic value of demonstrating microscopically with the Verhoeff-Van Gieson stain the presence or absence of venous invasion by the tumor. Before the clinical follow-up of these patients with leiomyosarcomas had been made, the pathologists re-examined the microscopic slides and grouped those in which venous invasion was observed (Fig. 5) separately from those in which no vascular invasion was seen. There were seven patients with venous invasion and six of these have subsequently died from a recurrence of their tumor. The seventh patient is living but only four months have passed since his operation.

None of the five patients with tumors in which venous invasion could not be demonstrated has died with tumor. One died postoperatively. Two are living and well ten and seven years, respectively, after their resection. Two died from cerebrovascular accidents six and three years, respectively, after their operation but in each instance an autopsy revealed no tumor.

The thirteenth patient had her original tumor excised elsewhere and there is too little residual tumor tissue in the secondary Johns Hopkins gastrectomy specimen to evaluate venous invasion.

These data suggest that all resectable gastric leiomyosarcomas should be removed regardless of their size. Although a resection may be curative when the tumor has not invaded veins, it is unlikely to be for angioinvasive leiomyosarcomas even though the tumor appears to have been completely removed. This suggests future consideration of curative resection with some additional form of treatment. Since leiomyosarcomas are radioresistant, possibly chemotherapy may be beneficial. Theoretically, the most effective time for its administration would be during and immediately after the operation.

Approximately a third of these patients with primary gastric sarcomas of all three types are either still living and well or have died from other causes while free of their tumor. Three patients are still living but not well, while slightly more than one-half the patients have died from sarcoma.

SUMMARY AND CONCLUSIONS

1. Twenty-eight cases of proven primary sarcoma of the stomach with complete follow-up have been analyzed. There were thirteen reticulum cell sarcomas, thirteen leiomyosarcomas and two lymphosarcomas.

2. The youngest patient was seventeen and the oldest was seventy-two years old, with the largest number diagnosed in the sixth decade. The age and sex distribution of the reticulum cell sarcomas and the leiomyosarcomas was remarkably similar. Neither age nor sex appeared to influence the results.

3. The symptoms and signs formed no characteristic pattern.

4. Reticulum cell sarcomas were most satisfactorily treated by resection and postoperative radiotherapy.

5. One patient with lymphosarcoma has had prolonged palliation with repeated radiation and chemotherapy.

6. Leiomyosarcomas were most satisfactorily treated by resecting any that were resectable, regardless of size. In this group lymph nodes were rarely involved and distant metastases were both infrequent and late. The histologic finding of venous invasion by the tumor indicates a poor prognosis by resection alone and suggests the future consideration of supplemental chemotherapy.

DISCUSSION

JOHN J. BYRNE (Boston, Mass.): What type of chemotherapy are you using on leiomyosarcoma?

RICHARD T. SHACKELFORD: At the present time, we are contemplating mustard, because we have had more experience with it than we have had with any of the other chemotherapeutic agents.

JOHN J. BYRNE: Dr. Hoerr sitting beside me, had mentioned that 10 per cent of his malignancies have been sarcomas. Since this is much higher than that seen by the majority of surgeons, I wonder if he would like to discuss this problem.

STANLEY O. HOERR (Cleveland, Ohio): I stayed away from the sarcoma group in my own figures this morning because I knew it was going to be discussed by Dr. Shackelford. I have seen twenty-four patients in the ten year period that I have studied these lesions. They have been about equally divided between reticulum cell sarcoma, lymphosarcoma, Hodgkin's disease and leiomyosarcoma.

I think it is worth commenting that often the surgeon does not know that this is going to be in the lymphoma group at the time that he is doing his resection; and when it is a localized lesion, as it was in some of your cases, Dr. Shackelford, I think the results are very good whether you use radiation or not.

I have had two five year survivors of ulcerations which proved to be reticulum cell sarcoma and which I thought were just ordinary ulcers at the time of removal.

We have tended to do local excisions on leiomyomas and the leiomyosarcomas and, again I have been impressed with the fact that pathologists study the sections a long time before deciding that one lesion is a leiomyosarcoma and the other a leiomyoma.

I am very interested in the point that you made about blood vessel invasion and I am going to look over our own cases from that standpoint.

JOHN J. BYRNE: It seems to be the consensus of opinion that if you have a sarcoma of any type that is localized to the stomach without lymph gland invasion, a local excision is satisfactory. If the lymph glands were positive, however, or there is vascular invasion, something else would be done, either x-ray therapy or chemotherapy, depending on what sarcoma is present.

Acute Gastric Dilatation

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ACUTE gastric dilatation, first recognized by Duplay in 1833, was explained on a pathologic basis by Rokitansky [20] in 1842, and on a clinical basis by Fagge in 1873 [8]. Since these classic studies, a host of other investigators have concerned themselves with all phases of the condition. Although not as lethal as the 63.5 per cent mortality rate reported by Laffer [14] in 1908, it still can challenge the diagnostician and be an occasional cause of death.

Seventeen fatal cases were found in the autopsy files of the Boston City Hospital. The period covered was 1935 through 1959, and these records serve as the basis for the clinical portion of this report. Since the autopsy rate over this period is about 30 per cent, it is probably safe to assume that three times this number have actually died of the disease. In addition to a review of these fatal cases, a series of experiments were performed on dogs to accentuate and clarify some of the physiologic and biochemical results of this condition.

CLINICAL ASPECTS

The cardinal features of this syndrome are varying degrees of abdominal distention, regurgitant vomiting of small amounts of gastric contents, respiratory embarrassment and vascular collapse. Secondary signs are cyanosis, increased sweating, coldness, abdominal discomfort, hiccoughs or scanty urine.

A few brief case reports follow to demonstrate the variety of clinical situations produced by acute gastric distention.

A sixty-five year old woman entered the hospital (A51-163) with the chief complaint of dyspnea on exertion. She had noted abdominal enlargement associated with vomiting and anuria for two days. With the increase in abdominal distention, the dyspnea became progressively worse. Physical examination revealed an enlarged heart, a blood pressure of 200/80 mm. Hg, and marked distention of the abdomen in all quadrants. The abdominal wall was very tense and tympanitic and bowel sounds were absent. She was placed in bed and oxygen was administered with a face mask.

The patient became increasingly dyspneic and orthopneic, and very coarse rales and rhonchi were heard throughout the lungs. Blood pressure fell precipitously and pulse was unobtainable. Despite positive pressure oxygen the patient did not respond and died at 8 P.M. At autopsy the stomach and first portion of the duodenum were markedly dilated with the right diaphragm elevated to the third interspace and the left to the fourth intercostal interspace.

A twenty-eight year old woman with severe wasting from chronic arthritis had severe dyspnea from pulmonary fibrosis and bronchiectasis for which she was hospitalized (A41-311). On the fourth day of hospitalization, she began to vomit small amounts of dark, almost black, thick material. There was no evidence of abdominal distention or pain. Despite the administration of parenteral fluids, the patient became rapidly worse and died. At autopsy the stomach was of tremendous volume, extending from the diaphragm to the brim of the pelvis.

Cryptic progress notes culled from other records further depict the tragedies due to physicians' ignorance of this benign disease and its treatment as well as its varied clinical manifestations.

A fifty-seven year old patient (A51-355) with decompensated rheumatic heart disease had been severely dyspneic for two days and received oxygen by catheter. She had vomited, which was believed to be due to digitalis intoxication. The next day the examiner noted that the stomach was distended and a succusion splash was audible. Gastric aspiration was performed at 3 P.M. and 500 cc. of fluid were obtained. At 9 P.M. this procedure was repeated and 1,000 cc. of fluid were removed. The

patient was extremely dyspneic. She was placed in an oxygen tent, grew rapidly worse, and died at 5:55 A.M.

Another patient's record reads as follows (A34-120): "February 10, hysterectomy, ether anesthesia; February 14, patient vomiting; February 16, patient cold and clammy, pulse weak, treatment with morphine and oxygen but patient went downhill and died."

A twenty-nine year old diabetic woman entered the hospital (A44-546) in a coma. Ten hours after admission this patient, who had continued to show improvement, suddenly became pulseless and cyanotic and died within a few minutes despite treatment with oxygen and artificial respiration.

One fifty-five year old woman (A45-243) who underwent closure of a small bowel fistula was doing well postoperatively until the fifteenth day. She then complained of weakness and sweating during the night. Intravenous fluids and sedatives were given. Very suddenly she showed signs of increased intracranial pressure; the pupils responded sluggishly and her reflexes were absent. Her breathing became very labored. She died in spite of all supportive treatment.

Recognition of the many forms in which this condition appears clinically will enable the physician to treat it early when all that is required is gastric suction plus removal of any obvious cause of the dilatation. In later stages, restoration of blood volume by adequate fluid, electrolytes and blood replacement is mandatory.

MECHANISM OF DILATATION

There are two basic conditions necessary for this condition to develop: a source for distending gas or fluid and some obstructive factor which limits these to the stomach and duodenum. The distention may be due to an enormous quantity of fluid and gas averaging between 2 and 3 L. of fluid. Gillesby and Wheeler [9] reported one case in which 4,700 cc. were removed. In one of the cases at Boston City Hospital the pathologist reported that one patient had an estimated volume of 8,000 cc. of gastric liquid and gas. Concerning the enormity of the distention which results from this, one cannot resist quoting from a case reported by Laffer [14]: "No autopsy was obtained but an undertaker was immediately called to prepare her, and as the distention was so great that she could not be placed in a casket, a trocar was passed into the point of greatest distention just below the left costal border and a great quantity of gas and a quart of milky fluid smelling strongly of Hoffman's anodyne which had been given her was removed. This showed that the trocar was in the stomach."

This distention develops rather quickly. It may occur in less than fifteen minutes.

Although some observers have believed the distending material to be primarily fluid due to gastrorrhea [16], it is the consensus of opinion that the primary agent is a gaseous distention with the fluid component secondary to the effect of distention. This fluid may leak from disturbed capillaries and/or as proposed by Dragstedt [6], "the gastric and pancreatic juice cannot be resorbed due to the disturbed circulation in the distended viscus."

The gas may be due to gastric liberation from some food or medicine. High carbohydrate vegetables have been implicated. A case report by Tanner [22] is of interest: "A young man desired an aperient and so took a Seidlitz powder. This powder consists of a blue packet containing sodium potassium tartrate with sodium bicarbonate and a white packet containing tartaric acid. The two are put into a half pint of cold water, when much gas is given off and the fluid should be drunk while effervescing. This young man unwisely swallowed the acid first and then swallowed the bicarbonate, so that all the carbon dioxide was liberated in his stomach. He afterwards declared that his stomach exploded and that he was thrown against a wall. This was followed by severe abdominal pain and my ex-registrar, Mr. Leo Gottlieb, operated on him a few hours later and found a long tear in the stomach, unassociated with any ulcer. Fortunately he made a good recovery."

In most cases the air is either swallowed or sucked through the esophagus into the stomach. The latter mechanism is most intriguing and has been well described by Morris, Ivy and Maddock [17]. The negative intrathoracic pressure can suck air down the esophagus if there is relaxation of the superior esophageal sphincter.

If there is dyspnea or other respiratory difficulty, the negative intrathoracic pressure may become a more influential factor. Klemptner [13] thought that "a common factor in all cases of acute dilatation of the stomach associated with surgery is the disturbed respiratory

FIG. 1. Photomicrograph of superior esophageal sphincter of dog demonstrating thickened tunica mucosa.

mechanism." Elreck and Heard [7] reported two cases following thoracic injury which were associated with grunting respiration. Anesthetists should be aware of this since positive pressure anesthesia may force air or gas through a sphincter relaxed by anesthesia or hypoxia [18]. In fourteen of the seventeen fatal cases at

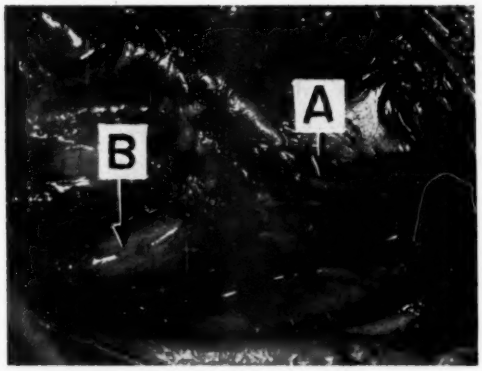

FIG. 2. Dissection of cervical region of the dog demonstrating site of superior esophageal sphincter where fibers of inferior pharyngeal constrictor blend with esophagus (A) and normally prevent atmospheric air from entering esophagus (B).

Boston City Hospital, there was a background of respiratory difficulty of some sort ranging through dyspnea, orthopnea, tachypnea, marked sighing with deep breathing, and severe coughing. The causes were cardiac disease in five patients, bronchopneumonia in five, emphysema in two, and diabetic acidosis in two.

The superior esophageal sphincter is a circular striated muscular ring in the upper esophagus which blends with muscular fibers of the inferior pharyngeal constrictor. The mucosa forms a thickened fold over the muscular thickening. (Fig. 1.) This sphincter ordinarily prevents atmospheric air from entering the esophagus. (Fig. 2.) When it is cut for demonstration purposes (Fig. 3), air readily is forced through it and can then be sucked into the

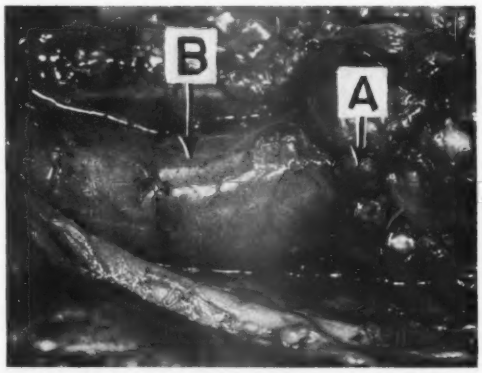

FIG. 3. Section of superior esophageal sphincter (A) permits atmospheric air to enter esophagus (B).

FIG. 4. On inspiration the air in the esophagus is sucked into the thoracic esophagus.

thoracic esophagus and stomach with each inspiration. (Fig. 4.)

Relaxation of the superior esophageal sphincter may be due to the muscular weakness caused by debility or disease, deformation by a tube passing through or near it, a nervous reflex mediated by stimulation of the sub-diaphragmatic vagus [17], or acquired through practice of esophageal speech after laryngectomy. The tube deformation is of special interest since the nasal catheter is often used for administering oxygen for dyspnea. Marrs et al. [15] reported seven cases of acute dilatations with six deaths wherein nasal oxygen played such a role. It appeared to be a factor in four of the cases at Boston City Hospital and positive pressure oxygen through a face mask was definitely involved in one case.

The localization of fluid and gas to the stomach and often to the first and second portions of the duodenum was first thought by Rokitansky to be purely anatomic obstruction of the duodenum where it passes over the spine and is compressed by the superior mesenteric vessels or the mesentery itself as they descend in the abdomen. Emaciation from debilitating diseases, the immedate postpartum period, or pelvic adhesions could pull the small intestine into the true pelvis and accentuate compression by the mesenteric vessels. One cannot overlook the factor of emaciation which was found in nine cases in this Boston City Hospital series. Rather than being a mechanical factor, however, its high incidence in this fatal series probably has other implications. Such cachexia could mean hypoproteinemia with its associated tendency to paralytic ileus or its effect on diminishing blood volume making such individuals more prone to hypotension. In other instances the cachexia has been an indicator of severe cardiac or pulmonic disease and made its victims easy prey for conditions imposing a strain on the cardiovascular system.

The dilated stomach can reinforce obstruction by pushing the intestines further into the pelvis or by direct compression on the duodenum as it passes over the vertebral column. Obviously, patients with a lordosis would be more subject to such obstruction. Thus, this may relate to the so-called "Cast Syndrome" recently reviewed by Dorph [5] in which the localizing factor appeared to be a distortion of the spine due to the molding of a plaster cast. Other sites for distention induced by obstruction could be the first portion of the duodenum or the ligament of Treitz. One stumbling block in the primary obstruction theory is the inability to decompress the distended viscus by vomiting. Another obstruction apparently was needed at the esophagogastric sphincter due to a folding of the mucosa as proposed by Kelling [12].

Definite obstructing causes were found in only five of the seventeen cases at Boston City Hospital: an aortic aneurysm, cancer of the pylorus, duodenal ulcer, incarceration of a diaphragmatic hernia, and a volvulus of the pyloric portion of the stomach. Although not an important factor in the usual acute gastric dilatation, it is well to emphasize that anatomic localizing factors may be present. We should heed the advice of Beck [1] who realizes that a careful x-ray study should be carried out after treatment of acute cases to determine whether a chronic duodenal ileus of some type is still present.

A more logical concept for the localization of gas and fluid to the stomach is a disturbed nervous reflex producing a paralytic ileus confined to the stomach. This concept was first theorized by Brinton in 1859 and has had many advocates. It must play an important role since it is obvious that there could be no gastric distention if normal vomiting occurred. However, it is more than a purely local affair and may embrace the entire vomiting reflex circuit. There are many disease states associated with paralytic ileus, the more important of which are infection, trauma, irritating fluids in the peritoneal cavity, metabolic defects and spinal cord diseases [3].

Recent studies have emphasized the metabolic effects of electrolyte deficiencies as a chief factor in the gastric atony [9].

Streeton and Ward-McQuaid [21] have reviewed this aspect of the syndrome in thirteen patients and found evidence of adrenocorticoid hyperactivity with abnormal prolongation of postoperative eosinopenia, excessive potassium loss in the urine and retention of water, sodium and chloride which reverted to normal on recovery. Simultaneous changes in the electrocardiogram were prolonged Q-T intervals and S-T segment depressions. Carlson and Ortiz [4], however, found no evidence of corticoid abnormalities in their patients. Such electrolyte deficiences are only one of the many factors that can cause paralytic ileus.

Some cause for paralytic ileus could be found in all the cases at Boston City Hospital in which the patient did not have an organic obstruction. Six patients had cardiac decompensation, five had bronchopneumonia, and two had diabetic acidosis. In no lethal case was alkalosis a factor. This probably reflects the fact that fifteen of the seventeen cases occurred on medical wards and alkalosis is usually seen on a surgical ward with its attendant gastric suction. It does emphasize, however, that electrolyte deficiencies are not the sole cause of this condition which apparently can arise from many disordered physiologic and anatomic states.

Many efforts have been made to produce gastric dilatation experimentally in animals. These have included vagotomy, vascular gastric ligation, gastric torsion, hydrochloric acid in the peritoneum, blood in the retroperitoneum, ureteral distention, and many other mechanisms. However, none have been uniformly successful. We have attempted various ones in our laboratory and have similarly been unsuccessful, but it is my opinion that the proper combination of section of the superior esophageal sphincter together with something which will produce dyspnea will eventually be successful.

RESULTS OF GASTRIC DILATATION

Regardless of the cause there are many deleterious effects of prolonged gastric distention which may produce a high mortality if not relieved rapidly. In order to study this aspect of the problem, we produced acute gastric dilatation in many dogs by ligating the duodenum and pumping a mixture of air and water into the stomach. In order to prevent regurgitation of this material the cervical esophagus was ligated around the stomach tube.

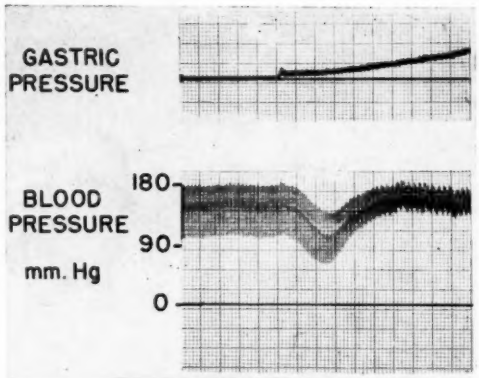

FIG. 5. Transient fall in blood pressure of the dog during initial stages of gastric dilatation associated with bradycardia and mediated through vagus nerve.

Reflex hemodynamic changes may occur mediated via the vagus nerve resulting in a drop in blood pressure and a bradycardia. In the healthy animal such effects are transient. (Fig. 5.)

Mechanical circulatory effects may be due to compression of the vena cava and aorta de-

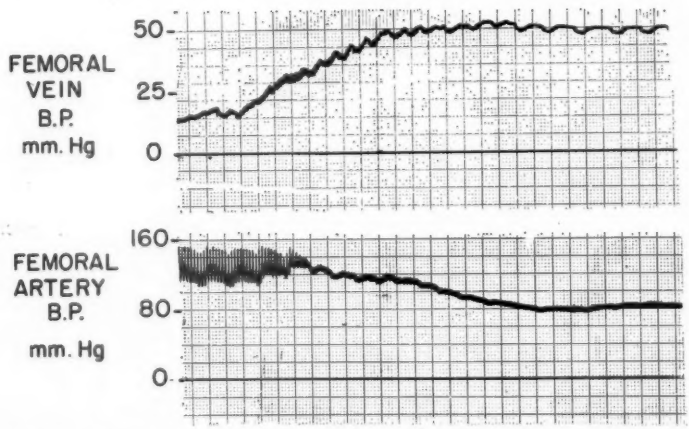

FIG. 6. Mechanical hemodynamic effects of gastric dilatation due to pressure of this viscus on the inferior vena cava and aorta resulting in rise of femoral vein pressure and fall in femoral artery pressure.

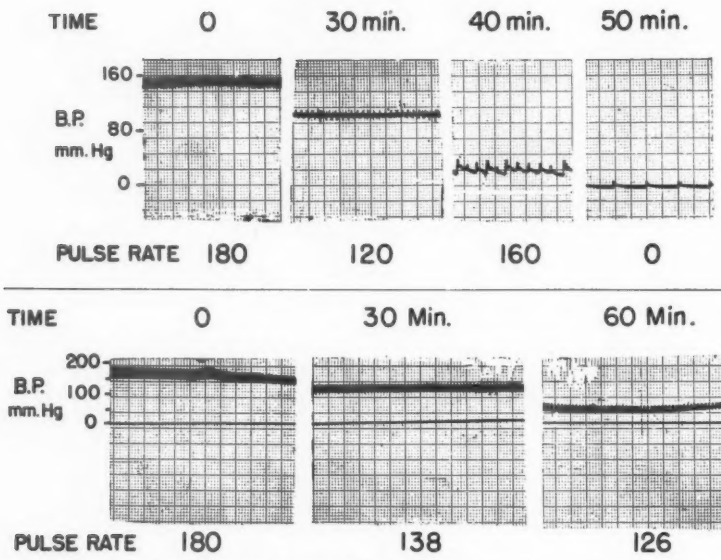

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FIG. 7. Fairly rapid fall in carotid artery blood pressure in experimental gastric dilatation.

FIG. 8. Hypotension produced by gastric dilatation i s uninfluenced by vagotomy.

pending upon the severity of distention. Figure 6 shows obliteration of the femoral pulse and a rise in the femoral venous pressure with the onset of gastric distention. Lest one think that this is too abnormal a situation to compare with human cases, I quote a case reported by Bolt [2]. A thirty-seven year old mental patient had a grossly distended abdomen, mottled cyanosis, a normal blood pressure in the arms but absent pulses in the legs which were mottled and anesthetic. The femoral pulses returned on evacuation of the distention.

The general trend is a drop in blood pressure of varying degrees at various times. A few animals withstand hours of distention with only moderate depressions of blood pressure and some succumb within forty-five minutes. (Fig. 7.) One animal had a blood pressure of 161/135 mm. Hg with a pulse rate of 180. Thirty minutes after distention of the stomach with 2,000 cc. of water and 1,000 cc. of air the blood pressure fell to 107/97 mm. Hg with a pulse of 170. Forty minutes later, the blood pressure was 39/19 and the pulse 160. Fifty minutes later the blood pressure was zero and no respirations were discernable. This drop in blood pressure is relatively uninfluenced by vagectomy. (Fig. 8.)

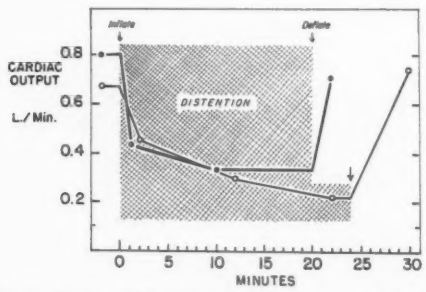

FIG. 9. Gastric dilatation produces a marked fall in cardiac output which immediately returns to normal when the stomach is deflated.

Cardiac output, measured by the indicator dilution technique using indo-cyanine-green dye and a Colson cuvette densitometer, revealed a progressive drop in output during the course of distention which reversed to normal after deflation of the stomach. (Fig. 9.)

This rapid return to normal dynamics after deflation would seem to indicate that a large portion of the circulating blood is sequestered somewhere in the vascular compartment, in the portal and/or the inferior vena caval beds. Evidence for this may be seen in the pathologic specimens of the fatal cases which almost always show liver, spleen and kidney congestion. Also, restoration of normal hemodynamics does

not mean that the animal is saved since most of them will eventually succumb in their cages. This probably means that the poor circulation engendered by sequestration of the blood produced ischemic tissues which were not able to survive the catastrophe.

Detailed studies of respiratory rate, tidal volume, minute ventilation, expiratory and inspiratory airway resistance and lung compliance were done on two animals. With the onset of distention, apnea occurred which soon disappeared as the animal compensated for the encroachment on his thoracic space by a diminished tidal volume and an increased respiratory rate. Eventually, as the blood pressure falls and the animal succumbs, there are gasping respirations followed by cessation of breathing. Of importance during this sequence is the marked increase in inspiratory and expiratory resistance probably due to mechanical narrowing of the bronchial tree. (Fig. 10.) There is a severe drop in lung compliance relatively soon after distention which exacts a great degree of work effort from an animal already burdened by hemodynamic difficulties. The initial apnea seen by us also was found by Kay and Phillipson [*11*].

It is conceivable that prolonged gastric dilatation could result in the loss of hydrogen

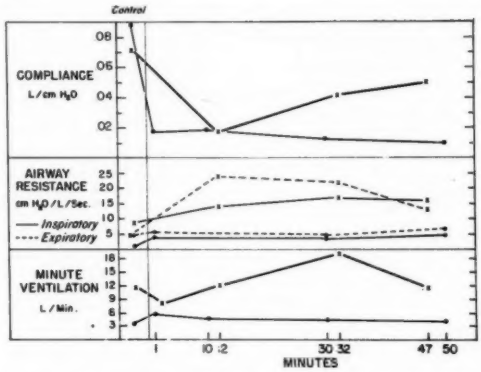

FIG. 10. The most marked changes in the respiratory dynamics of acute gastric dilatation is the fall in compliance probably due to encroachment of thoracic space by elevation of diaphragms.

ions and alkalosis with a low serum potassium. Jopsin [*10*] (1925) was one of the first to report such a case with elevated CO_2 combining power and convulsive seizures. However, we have been unable to produce these changes in the experimental animal even if the distention exists for many hours. Sodium, potassium and chloride determinations were done during the course of the distention in four animals, but few changes

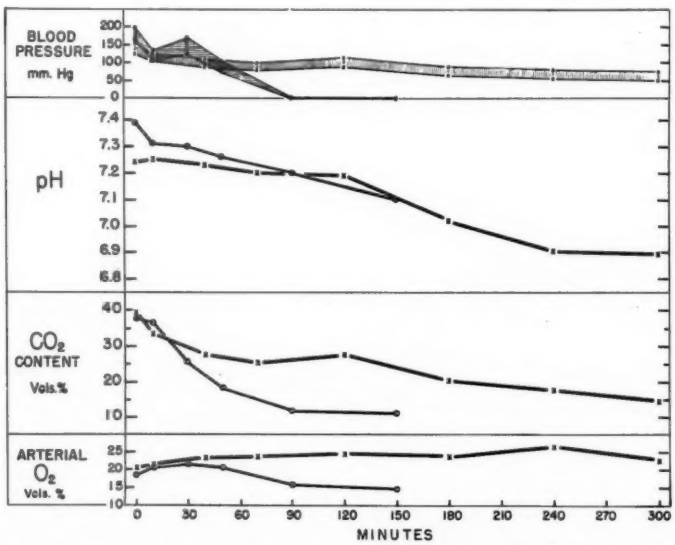

FIG. 11. Biochemical changes in acute gastric dilatation in dogs. Metabolic acidosis produced by ischemia.

were noted save for the chloride which varied depending upon the CO_2 combining power. This is at variance with speculations by Dragstedt et al. [6] who believe the symptoms in gastric dilatation are due to the electrolyte losses with resultant hypochloremia and alkalosis. It would seem to me, however, that such losses are the cause of the predisposing paralytic ileus and not an effect of the gastric dilatation.

We have found acidosis, rather than alkalosis, in every case studied. In two animals careful determinations were made of pH, CO_2 content, arterial oxygen content, and the blood pressure. (Fig. 11.) A progressive fall in CO_2 content is noted associated with a drop in blood pressure and pH. These changes are not due to respiratory difficulties since the arterial oxygenation does not change until the blood pressure is zero. They are examples of metabolic acidosis and are apparently due to tissue hypoxia in the regions where blood is sequestering.

To summarize the results of experimental gastric dilatation, it would appear that there are mechanical problems in hemodynamics and respiration which eventually produce profound physiologic and biochemical changes extremely detrimental to the organism.

SUMMARY

A series of seventeen fatal cases of acute gastric dilatation were briefly reviewed as a background to a general discussion of the clinical aspects of this problem as well as the causative factors. It is apparent that no one cause is responsible for gastric dilatation, but a combination of respiratory difficulty associated with conditions predisposing to paralytic ileus is the most usual situation. Occasionally, a localizing factor may be present which can produce a chronic dilatation of the stomach with an acute exacerbation.

A series of experiments was performed to investigate the defects of gastric dilatation on a normal animal and appeared to show that severe mechanical respiratory and hemodynamic changes are induced which lead to profound biochemical and physiologic changes.

The best treatment is a general awareness of the problem so that early diagnosis can be made at a time when simple gastric suction will alleviate the problem. The longer it persists, the more resuscitation will be necessary in the form of fluid and blood. If allowed to remain unchecked, the changes may be irreversible.

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DISCUSSION

Stanley O. Hoerr (Cleveland, Ohio): I went through five and a half years of an accredited

residency without ever seeing a case of acute gastric dilatation, or I did not recognize it if I saw it. I really very much doubted if the people who were writing about it knew what they were talking about. In a hospital overseas, we received a young soldier who had been peppered with shell fragments but there was no evidence of penetration into any of the major body cavities. He went into collapse. We inserted a Levin tube and aspirated 3 or 4 liters of fluid and air. The patient had a fairly prompt recovery.

After the war we saw several other examples of it. I treated a patient who collapsed seven or eight hours after a full dental extraction. The resident on duty had ordered roentgenograms of the chest and abdomen, and it was clear that she had a pneumoperitoneum. She was taken to the operating room and very little anesthesia was given. As soon as the peritoneum was opened we heard a sound like gas, the abdomen descended and the patient returned to consciousness. We enlarged the opening and found large tears in the stomach. The patient had an acute gastric dilatation with spontaneous perforation of the stomach.

One other case is allied to this and is of some interest to me. A patient had a gastric resection. The family thought the patient was getting a little "full in the face," and they called it to the attention of the nurse. It finally was very apparent that this patient had nearly doubled in size. Oxygen had been forced down the Levin tube, through the anastomosis, and found its way into the subcutaneous tissue. The patient ultimately recovered from the emphysema after a good deal of mental trauma.

E. Everett O'Neil (Boston, Mass.): Interestingly enough, one of the very common things we saw during my internship was acute gastric dilatation. How did we treat it in those days? By hot packs and ordinary supportive treatments, but also by a rather ruthless approach; that is, we put a stomach tube down and simply sucked it out much in the same manner that we used to wash out the alcoholics.

Richard T. Shackelford (Baltimore, Md.): I am so glad to hear that some of us have been interested in the physiology of this as I have never been sure as to which came first, the hen or the egg. This was the most common complication we observed after abdominal surgery during my resident days. In order to prevent gastric dilatation, I use indwelling nasogastric tubes in most gastrointestinal operations. In my day, the intern put a large gastric tube into the stomach on the third postoperative day if the patient's abdomen was distended. He irrigated the stomach and then instilled about 3 ounces of castor oil. In spite of this treatment, the patient usually died. I think Dr. Wangensteen's greatest contribution has been the use of the gastric tube. Since it has been used, gastric dilatation has occurred rarely.

Massive Upper Gastrointestinal Bleeding

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SUDDEN, painless, massive bleeding from the upper gastrointestinal tract is a continuing problem here at the Boston City Hospital. We first became interested in the problem about six years ago because of the high mortality in surgical treatment and the diversity of criteria for therapy which exists in the literature and in this hospital.

The material discussed herein represents 180 consecutive cases, unselected, operated upon on the Third Surgical Service for massive upper gastrointestinal bleeding. The period covered is from January 1951 to January 1960. This number includes both private and ward patients. All of the latter except one have been operated upon by chief residents. The ages ranged from seventeen to eighty-two years. (Table I.) Table II shows the incidence and site of bleeding in females. It is quite difficult to find any comparable study in the literature due to different definitions of massive bleeding and, most important, to the different types of patient population. This latter fact makes this material unique. Patients who bled only from esophageal varices have been excluded from this study.

In the course of this continuing study it has become increasingly apparent that a standardized approach to the problem is a *sine qua non* for success. Although it is obvious immediately to those with experience in the treatment of massive bleeding that one cannot categorize every patient who is bleeding into a plan, by the same token, one can tailor the plan to fit the treatment of the patient with bleeding. We have found that it is much easier to treat these patients with a well established *modus operandi* than to try to devise one on the spur of the moment particularly when the available moments may be all too few in some cases. There is no substitute for close, simultaneous medical and surgical observations and cooperation. Ideally, both the internist and the surgeon should interview and examine the patient as soon as he is admitted to the hospital or as soon as the problem of bleeding arises. This can frequently save valuable time, the expeditious use of which may be lifesaving later on.

The first portion of the *modus operandi* which can be easily standardized is the work-up. With proper organization even the youngest members of the house staff, who frequently may be the first to see the patient, can start the investigation in the right direction. Previous ulcers, bleeding episodes, previous gastro-

TABLE I
AGE DISTRIBUTION BY DECADES

Age (yr.)	Lived (No.)	Died (No.)
10–20	1	
20–30	6	
30–40	16	
40–50	24	3
50–60	39	7
60–70	25	15
70–80	23	13
80–90	3	5
Youngest 17 yr.		
Oldest 82 yr.		

TABLE II
INCIDENCE OF FEMALES IN SERIES AND LOCATION OF BLEEDING

Location	Number
Gastrointestinal ulcer	10
Duodenal ulcer	9
Both duodenal and gastrointestinal	1
Gastritis	5
Gastrointestinal polyp	1
Neurofibroma of jejunum	1
Abscess of jejunum	1
Total	28

intestinal operations, signs and symptoms of heart disease, alcoholism, jaundice and bleeding tendencies are sought out in the history. Special attention is paid to signs of cirrhosis, that is, ascites, spider angiomas, liver palms, gynecomastia, hemorrhoids and, of course, hepato- and splenomegaly.

While this is being done the laboratory work can be under way. Of course typing, cross-matching and ordering a supply of blood are important. Hematocrit, bleeding and clotting time, nonprotein nitrogen, bromsulphalein excretion, and prothrombin time are ordered. A smear should be obtained to note appearance and number of platelets. The stool and vomitus should be checked, the amount should be noted and the specimen should be tested for blood. If stool and/or vomitus is tremendous in amount or continuing, the plan may have to be altered immediately and such a patient taken directly to the operating room. If it is possible, a chest plate should be obtained when the patient is admitted or shortly thereafter. This may be of great value to the anesthetist if surgery is indicated, for it helps to solve the frequently difficult and complicated problems of anesthesia.

There has been much discussion and disagreement about the use and value of the barium study in the patient with serious bleeding. It now seems, as Rigler [*1*] has stated, that the concept that the welfare of the patient might be seriously prejudiced by taking the patient to the x-ray department, which pervaded the literature and our thinking for so many years, has been largely abandoned. Adequate therapeutic measures should be readily available when the patient is moved and the patient should be accompanied to the x-ray department by a member of the house staff familiar with the problem.

The radiologist defines a crater as "the persistent presence of a localized rounded collection of barium" [*2*]. The presence of a crater on roentgenogram indicates that the ulcer has penetrated into submucosa or muscle [*3*]. Gardner et al. [*4*] found in a series of cases of massive bleeding that there was a higher incidence of the presence of a crater in the more severely bleeding group. He further stated that when a crater is demonstrated in a patient with bleeding of duodenal origin that he should be operated upon more quickly. Our experience does not confirm this. If the stomach is full of blood or clot, vigorous manipulation to overcome this difficulty is certainly contraindicated. It is still very worth while, however, as a positive diagnosis is of inestimable help in cutting down operating time. As in all things, opinions vary. Bingham [*5*] of Ontario believes that "emergency gastrectomy is not indicated in the presence of normal no touch x-ray." I must disagree with this. Certainly, if one followed this rule, the mortality would be much higher. Dr. Max Ritvo, chief of our x-ray department, estimates that his staff demonstrates 30 to 40 per cent of lesions on roentgenograms of patients with massive bleeding.

At some time early in the work-up an electrocardiogram should be made and the medical consultant should give an opinion as to the type or class of operative risk that the patient represents at the same time. This often may depend on associated diseases as well as the bleeding. Also, it will save valuable time later if the decision to operate is made. Once this decision has been made there should be no delay. Even a slight delay at such time may be disastrous.

In this work-up we agree with Zamcheck et al. [*6*] that the bromsulphalein retention test is an excellent screening mechanism for severe liver disease and esophageal varices. When retention values are below 12 to 15 per cent, the chance that bleeding is from varices is extremely small. Occasionally because of bromsulphalein retention above this level and a negative gastrointestinal series the differential diagnosis between varices and ulcer may be extremely difficult. In such instances we have taken the patient to the operating room prepared for surgery. He is esophagoscoped on the operating table; and if this is negative for bleeding from varices, he is ready for immediate surgery without further lost motion. The physicians in the Chest Service at the Boston City Hospital have been most cooperative in this regard. A half dozen cases stand out vividly in my mind in which this procedure was of tremendous value. In three of these varices without bleeding were demonstrated and these were operated upon and salvaged. The others were bleeding varices and were treated accordingly.

There is another very intriguing test with which we have had no personal experience. In September, 1959, Panke et al. [*7*] reported on the use of splenic pulp manometry as an emergency test in the differential diagnosis of

TABLE III
MORTALITY FIGURES ON PATIENTS WITH CIRRHOSIS IN SERIES WITH AGE AND BROMSULPHALEIN RETENTION VALUES

Lesion	No.	Age (yr.)	Bromsulphalein Retention (%)	Lived (No.)	Died (No.)
Duodenal ulcer*.....	11	36–73	11–49	3	8
Gastrointestinal ulcer†.....	8	37–70	19–24	4	4
Duodenal and gastrointestinal ulcers*.....	2	60–64	0–28	0	2
Gastritis.....	3	63–80	21–38	1	2
			Total	8	16‡

* One bled fatally from varices.
† Two had varices; one bled fatally.
‡ Mortality 66.6 per cent.

bleeding from the upper gastrointestinal tract. According to them the procedure is relatively simple, direct and safe. In a series of 113 patients with bleeding the test has proved to be 90 per cent accurate in determining the absence or presence of esophageal varices. A No. 18 spinal needle is used with local anesthesia. It is inserted in the left ninth intercostal space in the posterior axillary line during apnea. The needle goes 1 to 3 cm. into the pulp. A constant drip of blood confirms the intrasplenic location. A water manometer (with the zero point at table level) with a short length of rubber or plastic tubing between the needle and the manometer prevents a rigid system and tearing of the spleen. The needle is cleared of pulp with 1 to 2 cc. of saline. There is a corrected baseline of 12 cm. above the table for transposition to portal pressure. Reading above 290 mm. H_2O indicated varices. The area of overlap was between 250 and 290 mm. Varices are an important focal point in this disease. One of the most important things learned from this study, and which was first emphasized by our own pathology department, is that cirrhotics can die from bleeding ulcers as well as from bleeding varices. The statistical significance of the combination of cirrhosis and massive upper gastrointestinal bleeding is pointed out in the mortality figures in Table III.

By whatever criteria one might wish to use, these patients all had massive bleeding. Unfortunately, blood volume studies are not available. As Stewart [8] points out, the measurement of the total circulating red cell mass is most important in determining the amount of hemorrhage. Again, as we are all aware, he states [9] that during the earlier stage of severe hemorrhage vasoconstrictive shunts and delay in hemodilution may suffice to maintain systolic blood pressure when the red cell mass is falling. All of these patients displayed signs and symptoms of shock, had significant fall in hematocrit values and needed from 5 to 21 units of blood prior to surgery.

Stewart [9] states the simple facts that bleeding patients die of anoxia and that the longer anoxia remains uncorrected, the greater the danger (point of no return); there is no substitute for hemoglobin in the anoxia of hemorrhage and this must form the conceptual basis for the management of this disease. The obvious question of why this bleeding should be treated differently from ruptured spleen or ruptured ectopic pregnancy has a partial answer in that the procedure usually is a much more serious one. However, the fundamental facts are the same.

The decision to operate can be difficult to make. I sometimes am certain that we make it more difficult than it really is. This is understandable when the risk presented by operating upon some of these patients is pondered. We have found that decisions can be made more easily and expeditiously by having a rather flexible *modus operandi* and modifying it to fit individual situations.

Our *modus operandi*, which is not original, is as follows:

1. Rate of bleeding is considered. If more than 4 units of blood are needed to return the pulse and blood pressure to normal, the patient is considered to be exsanguinating and is operated upon. If over 4 units of blood are required during the first twenty-four hours or over 3 units on the second day to maintain the hematocrit values within normal limits the patient is operated upon; the latter is equivalent to continued bleeding.

2. After forty-eight hours of continued bleeding operation should be performed. The point of no return may be reached in this group due to possible anoxia or adrenal exhaustion.

3. If recurrent hemorrhage occurs while the patient is in the hospital, one should operate at once.

4. A combination of bleeding and obstruction calls for immediate surgery. Here one can think of an important modification, i.e., the amount

TABLE IV
TABULATION OF PREVIOUS BLEEDING EPISODES

Number	0	1	2	Multiple
Lived	89	30	10	8
Died	31	9	0	3

of available blood if the patient is a rare blood type.

The importance of the rate of hemorrhage was well pointed out in 1948 by Hoerr, Dunphy and Gray [*10*] when they said that failure to maintain stable circulation (syncope or hypotension) with 500 cc. of blood every eight hours demanded surgical intervention. They also noted several basic facts, namely, that the patients over fifty years of age are less likely to stop bleeding, that the first hemorrhage carries the higher risk and that risk of death increases with duration of hemorrhage. Syncope may be more important than believed in this regard. Bandler [*11*] showed in a series of 162 patients with bleeding duodenal ulcers that syncope commonly heralded a massive hemorrhage. As is commonly accepted, he also showed in this group that the silent, painless bleeder is the more severe type. Table IV shows the number of previous bleeding episodes in this series. It is to be noted that thirty-one of the forty-three patients who died had had no previous episode of bleeding.

Many sets of indications have been discussed in the literature but few seem to stress the rate of bleeding as much as we think it should be stressed. Some stress very controversial points. For example, Baker [*12*] suggested avoiding early surgery when the site of bleeding has not been established as one may overlook erosions in the fundus. Many of these patients in our series would not have survived if handled in this fashion. As we shall point out later, bleeding points in the fundus should not be missed at operation.

When the decision to operate has been made, this can be accomplished efficiently if a routine has been set up. When the abdomen is opened, a quick survey is made for evidence of other disease. Then, unless the bleeding site is obvious, gastrotomy is performed. It must be large enough to be useful. It is at this point that the fundus is inspected either directly with suitable retraction, the method we prefer, or indirectly with the aid of a sigmoidoscope. If this technic is used, bleeding at the fundus should not be missed. If bleeding is not observed at this point, the pylorus may be cut across and the duodenum opened. The upper jejunum should be carefully examined and palpated and opened if it seems appropriate after the duodenum is determined to be normal. This type of procedure was well described by Osborne and Dunphy [*13*] in a report on a series of 100 patients with massive bleeding who were treated in this hospital on the Fifth Harvard Surgical Service. Incidentally, they pinpointed five lesions that would have been missed by "blind gastrectomy."

TABLE V
LOCATION OF BLEEDING POINT IN PATIENTS IN THIS SERIES

Location	Lived (No.)	Died (No.)
Duodenal ulcer	64	19
Gastric ulcer	43	13
Both duodenal and gastric ulcers	0	2
Marginal ulcer	18	3
Gastritis	4	2
Gastrointestinal polyp	1	1
Carcinoma of stomach	1	3
Neurofibroma of jejunum	1	0
Abscess of jejunum	1	0
Undetermined	4	0
Total	137	43

If the bleeding point is found (Table v), it should be immediately controlled and the decision simply to secure the bleeder or to perform gastrectomy or other procedure must be made. The surgical procedures are: (1) vagus resection and gastroenterostomy or pyloroplasty; (2) ligation of bleeding point with or without ligation of vessel outside lumen (excision of ulcer); (3) high gastric resection without removal of ulcer; (4) high gastric resection with removal of ulcer. These procedures are listed in the order of desirability, No. 1 being the least desirable and No. 4 the most desirable.

We have not as yet employed procedure No. 1. If the bleeding point is not found, the old problem of blind gastrectomy arises. Many authors believe this is a satisfactory procedure even without exploration. Bruce and Dudley [*14*] (1959) reported a series of thirty-one cases with 17 per cent blind gastrectomies. They believe it will remove the lesion in 75 per cent of

TABLE VI
LISTING OF TYPE OF PROCEDURE PERFORMED IN TIHS SERIES

Procedure	Number
Partial gastrectomy	166
Re-resection	4
Ligation (1 with anterior gastroenterostomy)	5
Excision of ulcer	2
Resection of jejunum	2
No operation	1
Blind gastrectomy:	
Gastritis	3
Multiple gastric ulcers	1
Undetermined	1

TABLE VII
OVER-ALL MORTALITY FIGURES

Age (yr.)	Died (No.)	Cirrhosis (No.)
40–50	3	2
50–60	7	6
60–70	15	7
70–80	13	1
80–90	5	
Total 23.8% (15%)*	43	16

* Indicates mortality figure with exclusion of patients with cirrhosis.

the cases and arrest the bleeding in the majority of the remainder. Thieme [15] suggested that blind gastrectomy be performed if no lesion is palpable since he thought that gastrotomy prolonged the procedure and frequently did not reveal the bleeding point.

It is our firm conviction that blind gastrectomy without gastrotomy and exploration is not an acceptable procedure. However, after a thorough exploration as previously described fails to locate the site of bleeding, gastrectomy may be performed. This decision usually is based on the experience of the responsible surgeon. If blind gastrectomy without exploration is routine, many bleeders will be missed with tragic consequences. In this series, we performed five blind gastrectomies in four of which microscopic lesions were demonstrated. The procedures employed are listed in Table VI.

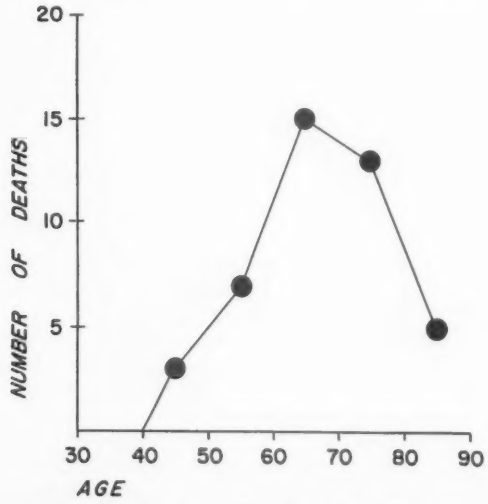

FIG. 1. Graph showing peak mortality in the sixth and seventh decades.

In massive upper gastrointestinal bleeding erosive gastritis can be a troublesome problem, as reported by Jankelson and Zamcheck [16] of this hospital. At operation blood seems to be oozing from the entire area of mucosa. In most of these (six) we have elected to do gastrectomies with good results except for two cases. Occasionally, as reported by Hardaway and Castagno [17] total gastrectomy must be done to stop the bleeding. They point out that recurrent bleeding may be due to the stress factor, transfusion reaction, prolonged surgery, trauma and shock. (The last four factors all concern intravascular clotting and the blood clotting defects which accompany it.) This area might be an appropriate one for the local gastric cooling technic of Wangensteen [18]. However, at the present time we do not have this equipment available.

Our gross mortality in this series is 23.8 per cent, as shown in Table VII. If corrected by excluding the patients with cirrhosis it is 15 per cent. As pinpointed in the graph (Fig. 1) the sixties and seventies are the most dangerous decades. Causes of death are tabulated in Table VIII.

Our experience would most certainly be poorer without our expert anesthesia. It is not impressive when looked at through the eyepiece of the mortality rate and with this we are certainly not satisfied. I have wondered if we could do any better with this type of patient population. It certainly is a rugged challenge.

TABLE VIII
LIST OF CAUSES OR CONTRIBUTING CAUSES OF DEATH

Causes	No.
Cirrhosis (complications)	13
Pulmonary (complications)	11
Cardiac (complications)	10
Renal shutdown	2
Recurrent bleeding	3
Cerebrovascular accident	1
Pulmonary embolus	1
Subphrenic abscess	1
Sepsis	1
Total	43

Welch [19] has stated that technical proficiency is of great importance. With this we heartily agree but wonder if it might have made the difference in the face of so many other factors. This proficiency is not always available on a teaching service. After careful scrutiny of the case reports of Smith and Farris [20] we do not believe that vagus resection and pyloroplasty is applicable to the type cases of bleeding seen here at the Boston City Hospital.

It has been our belief recently that several factors might help in lowering this figure. First, I believe that patients in the older age groups, many of whom have other serious diseases, should be operated upon much sooner. It may be that in some of these only ligation of the bleeder should be done as a first stage with the definitive ulcer-preventing procedure done at a later date.

Some thought should also be given to the possible use of red cells tagged with radioactive chromium. This was described by Izak et al. [21] in a procedure designed to determine the amount of blood loss in the stool and mention was made of a modification of the test which might be useful in determining the site of bleeding. This would be of great help. The availability of a rapid, accurate and easy test for blood volume would solve one of the most pressing problems. It is my firm conviction that in many of our patients who did not survive we never had a true hematocrit reading and thus may have been 2 or 3 units of blood behind all through the course of treatment.

Ours is a challenging target. Since it is usually the surgeon's lot to make the decision to operate or not, it is likewise probably up to us to solve the problem of this high mortality.

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DISCUSSION

Stanley O. Hoerr (Cleveland, Ohio): I do not think Dr. Miller has anything to be embarrassed about regarding the mortality rate here. I think that institutions that have comparable patients of a comparable age and with comparable debility have exactly the same mortality. My own personal mortality which includes patients who are operated upon as urgent bleeders rather than emergency bleeders is still over 10 per cent and we have a more favorable type of individual to deal with.

Doctors Ferris and Smith have reported on their work related to vagotomy and pyloroplasty. I have shared your skepticism as to whether this was a good approach for active bleeding of a duodenal ulcer, but Doctors Ferris and Smith are truthful people and I know of a case or two in which it seemed a good idea to try it.

One patient had a cholecystectomy. Two days after operation bleeding started from a duodenal ulcer and the patient was given 9 units of blood. Somebody peeked under the dressing on the ninth day and saw an evisceration and promptly transferred him to us. The evisceration had to be repaired and it seemed like a good idea to try to do something about the bleeding duodenal ulcer at the same time. We ligated the vessels and did a vagotomy and pyloroplasty, and I am happy to say that the patient didn't bleed again.

The first patient I tried it on was actively bleeding and in collapse, but he also had had a pulmonary resection for cancer of the lung some six months before and there was a metastatic tumor in the peritoneum. It seemed that if there was ever a good case in which to try something conservative, this was the one. I ligated the vessels, did a vagotomy and pyloroplasty and the patient did not bleed again.

Some night when the anesthesia may not be going too well and the patient has severe cirrhosis of the liver, it might be worth a try.

I would like to make one retraction also. In a paper published in *The New England Journal of Medicine* on this topic about ten years ago, I advocated doing a sterile gastroscopic examination with a sigmoidoscope. I am sure it is much sounder to do the wide gastrotomy that Dr. Miller talked about and have a direct look at the stomach.

Richard T. Shackelford (Baltimore, Md.): It took a wealth of material and a lot of work to make such a good analysis and I agree with everything you say, Dr. Miller. As far as blind gastrectomy is concerned, I am opposed to it unless you find actual blood in the stomach at the time of exploration. My reason is that about 25 per cent of upper gastrointestinal bleeding arises from a source other than peptic ulcer.

There is one cause of massive bleeding, jejunal diverticulitis, I should like to call to your attention since I do not think it is generally recognized. I am reporting twenty-four massive gastrointestinal hemorrhages from this cause. They are not always easily seen and one may have to distend the jejunum with air in order to visualize them. Just because diverticula are present doesn't mean they are necessarily bleeding. If you just pinch them a little with your finger, you may see the bleeding.

Someone will say: Why didn't you find this in the autopsy room? Dr. Arnold Rich said the reason we do not find this bleeding is because the pathologist takes out the intestine and slits it wide open. Thus the openings of the diverticula are obscured by the mucosal folds.

E. Everett O'Neil (Boston, Mass.): Dr. Osborne, I am wondering if you would like to say a word or two?

Melvin P. Osborne (Boston, Mass.): I would just like to comment on two things. One is to say that I enjoyed Dr. Miller's presentation. It sounds very much like a description of our experience on the Fifth (Harvard) Surgical Service, Boston City Hospital.

I will dwell for a moment or two on the matter of diagnosis. What does a positive x-ray film mean? What it means to the surgeon is that you can recommend surgery with a little more confidence and you can talk to the family about what you are going to do and not what you may be able to do. Among the many factors that influence the surgical versus the nonsurgical attitude are the rate of bleeding and its duration as well as the technical proficiency and experience of the surgeon. This includes experience on the part of the Anesthesia Service too.

We think that blind gastrectomy is better than no gastrectomy because there certainly is an incidence of 75 per cent of lesions that will be removed.

The Surgical Management of Acute Gastroduodenal Perforation

AN ANALYSIS OF 400 SURGICALLY TREATED CASES, INCLUDING 277 TREATED BY IMMEDIATE SUBTOTAL GASTRECTOMY

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AT the turn of the century, acute gastroduodenal perforation was one of the most catastrophic and fatal illnesses which the surgeon encountered. In most clinics the mortality rate was between 40 and 60 per cent, and in some series mortality rates as high as 90 per cent were recorded [6,16,19]. During the first four decades of this century, there was a gradual decrease in mortality so that by 1940 a collected series of 15,340 patients surgically treated for perforated ulcer revealed an operative mortality rate of 23.4 per cent [5]. In the ensuing years, the mortality rate has fallen even more rapidly due to the advent of antibiotics, a wider use of blood transfusions, intravenous fluids and other supportive measures. In a recent series collected by the authors, the operative mortality rate was 7.8 per cent in 3,506 cases [4].

Although subtotal gastrectomy has been utilized as a definitive procedure in some foreign clinics for many years, simple closure has been employed by most surgeons in the United States; only an occasional report of treatment by gastrectomy is encountered in the American literature [1,3,14]. Simple closure has been preferred because of the belief that the more extensive operative procedure would significantly raise the operative mortality rate and the belief that recurrence of an ulcer was unusual following perforation. Early studies seemed to support the latter concept, for Southam [18] found that 90 per cent of his patients remained well following simple closure, and White and Patterson [20] estimated that only 10 to 15 per cent of the patients required further surgery. In a collected series of 1,525 patients treated by simple closure, reported in 1940, 50 per cent remained symptom free and only 16.9 per cent required subsequent operation [5]. However, more recent studies have not supported these earlier observations, but instead have indicated that 50 to 75 per cent of patients treated by simple closure continue to have symptoms related to the ulcer disease, and that at least 35 per cent require additional surgery [10,11,15]. McCaughan and Bowers recently estimated that approximately 50 per cent of patients treated by simple closure will ultimately need surgery for recurrent ulceration. However, these authors still advocated simple closure as the treatment of choice for perforated ulcer because of their low operative mortality rate of 1.5 per cent, and because many patients may have several years of relative freedom from symptoms after closure of the perforation before resection is necessary [13].

A re-evaluation of this problem was undertaken ten years ago in our clinic for we believed that gastrectomy could be performed in properly selected patients without increasing the over-all mortality rate, and that this procedure should save many patients from a second major operation. Therefore, in January 1952, the policy of employing immediate gastrectomy as the preferred treatment for acute gastroduodenal perforation, unless there was some specific contraindication, was instituted. In 1954 we reported an analysis of the first 112 patients so treated [4]. This study strengthened our opinion that immediate gastrectomy could be performed on the majority of the patients without

TABLE 1

SURGICAL TREATMENT FOR ACUTE GASTRODUODENAL PERFORATION*

Treatment	Oct. 1950 to Dec. 1951		Jan. 1952 to Oct. 1954		Nov. 1954 to Dec. 1959		Total	
	No.†	%	No.†	%	No.†	%	No.†	%
Simple closure	48	72.7	22	17.0	40	19.5	110	27.5
Immediate gastrectomy	15	22.7	97	75.2	165	80.5	277	69.2
Delayed gastrectomy	3	4.6	10	7.8	0	0.0	13	3.3
Total	66	100.0	129	100.0	205	100.0	400	100.0

* Treatments in three periods between October 1, 1950 and December 31, 1959, are compared.
† Figures in this column represent the number of patients treated.

causing an undue increase in operative mortality. This program was continued to evaluate further the immediate and the long term results following this modality of therapy.

CLINICAL MATERIAL

The present study consists of an analysis of 400 patients with acute gastroduodenal perforation who were treated surgically at the Veterans Administration, Jefferson Davis and Methodist Hospitals between October 1, 1950 and December 31, 1959. We are of the firm opinion that, with rare exception, patients with acute perforation should be treated surgically. The few patients treated nonoperatively were excluded from this study. The majority of the patients were of the male sex. The age range was two months to eighty-five years with the highest incidence in the fourth decade. Three hundred forty-six patients (86.5 per cent) had ulcers in the duodenum, forty-four (11.0 per cent) had benign gastric lesions, seven (1.8 per cent) had marginal ulceration and three (0.7 per cent) had gastric carcinomas. For purposes of analysis, the patients were divided into three groups. The first group consists of those patients treated prior to January 1, 1952, when simple closure was the treatment of choice, subtotal gastrectomy being employed in only a few selected patients. The second period, extending from January 1952 to October 1954, represents the early period in which subtotal gastrectomy was utilized as the preferred treatment. The third period, November 1954 through December 1959, represents the most recent experience. (Table 1.)

Simple Closure. Since January 1952, simple closure has been utilized only with those patients in whom subtotal gastrectomy appeared to be contraindicated. The primary contraindication was the presence of associated severe systemic diseases which would increase the operative risk. Simple closure was utilized also in patients in whom shock developed prior to or during the operation, and it was used when the technical aspects of the operative procedure were complicated by the perforation. Neither the age of the patient, duration of ulcer symptoms nor the time lapse after perforation, *per se*, were considered contraindications to resection, though many patients in whom perforation had been present for over forty-eight hours were acutely ill, and intra-abdominal abscesses precluded the satisfactory performance of subtotal gastrectomy. Subtotal gastrectomy is not

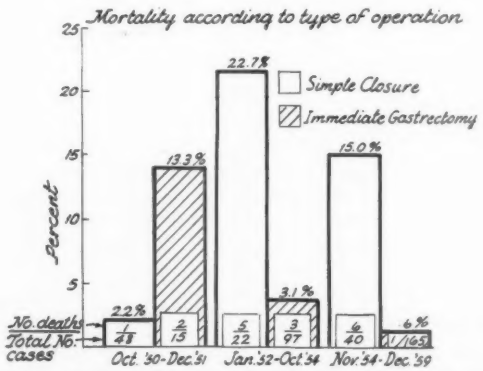

FIG. 1. Illustrated above is the comparison of operative mortality following single closure and immediate gastrectomy in three periods between October 1, 1950 and December 31, 1959.

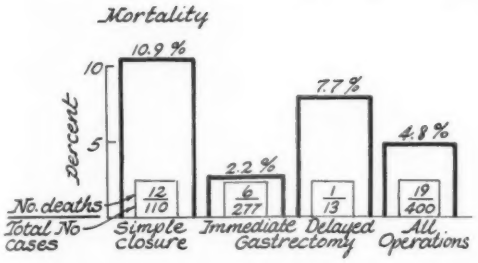

FIG. 2. This figure shows the mortality according to treatment.

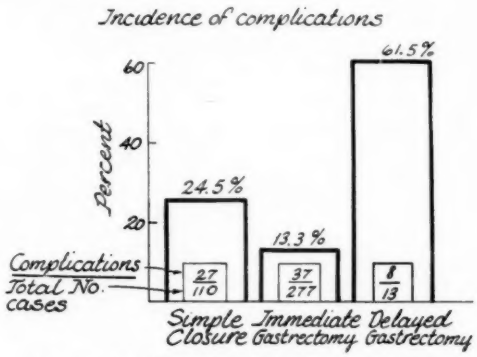

FIG. 3. Incidence of complications is depicted.

recommended when purulent peritonitis has developed.

A comparison of the operative mortality rates following simple closure during the three periods is of interest. When simple closure was used as the treatment of choice, it was attended with a low operative mortality rate, but during the period ending October 1954, there was a sharp rise, primarily due to the selection of patients. In the more recent series, however, the mortality rate for simple closure decreased, even though the incidence of immediate resection increased (Fig. 1), and the mortality rate for the entire group of patients treated by simple closure was only 10.9 per cent despite the fact that the majority of the patients were considered poor operative risks. (Fig. 2.) This rate is not greatly different from that reported by many clinics where simple closure is used as the treatment of choice [2,10,14,17].

The cause of death has shown a changing pattern for in recent years it was attributed to associated disease in most instances, whereas, in the earlier report [4], four of six deaths were due to severe complications of the perforation.

Immediate Gastrectomy. The frequency with which immediate gastrectomy was utilized increased markedly in the second period, as would be anticipated. There was a still further increase during the third period, so that currently 80.5 per cent of all patients are treated by immediate gastrectomy. (Table 1.) Despite the broadened indications for resection, operative mortality has continued to improve, there being only one death in the last 165 consecutive resections. (Fig. 1.) This was the death of a thirty-three year old man who had cardiac arrest at the end of the operation. The chest was opened and cardiac massage instituted, with resumption of heart beat; however, the patient had severe cerebral damage and died twenty days after the operation. The operative mortality for the entire group of 277 patients treated in this manner was only 2.2 per cent (Fig. 2), which is not significantly different from mortality rates commonly reported for elective surgery. It is noteworthy that only one patient in the entire series of patients, who were treated by immediate gastrectomy, died from a technical failure. This patient, as previously reported, died from a leakage at the site of anastomosis. Furthermore, the incidence of complications has remained low, being no higher than that following gastrectomy for other indications [9]. (Fig. 3.) In fact, one receives the impression that these patients have a smoother convalescence than patients treated electively. The incidence of postoperative complications has consistently remained lower than that following simple closure.

There have been changes in the technics of gastrectomy during the study. In 1952 virtually all patients were treated with the Billroth II procedure; but in 1953, an increasing number of patients were treated by the Billroth I procedure, the incidence being almost 60 per cent during this period. As will be noted later, our experience, as well as that of others, indicates that gastroduodenostomy is attended with a significantly higher incidence of marginal ulcer than gastrojejunostomy, and, therefore, in the last two years it has been abandoned [7].

Delayed Gastrectomy. Several years ago a few patients, who were not suitable candidates for immediate gastrectomy, were treated initially by simple closure; however, gastrectomy was performed three to four weeks later regardless of symptoms. The incidence of complica-

TABLE II
ACUTE GASTRODUODENAL PERFORATION*

Diagnosis and Procedure	Total Patients Treated	Patients with Marginal Ulcer	
		No.	Per cent
Duodenal ulcer	68	3	4.4
Billroth I	23	3	13.0
Billroth II	45	0	0.0
Gastric ulcer	3	0	0.0
Marginal ulcer	2	1	50.0

* Given above is the incidence of recurrent marginal ulceration in seventy-three patients following subtotal gastrectomy.

tions was extremely high. (Fig. 3.) This approach was abandoned.

LATE RESULTS

The follow-up studies concern only those patients treated at the Veterans Administration Hospital; the first ninety consecutive patients treated by gastrectomy have been reviewed. Seventy-five (84 per cent) of these patients have been followed from ten months to seven years with an average follow-up period of 2.7 years. Two of these patients were treated for perforation of the gastric wall due to carcinoma, and both died of recurrent carcinoma within one year following operation. Of the remaining seventy-three patients, sixty-eight had duodenal ulcers, three had gastric ulcers and two had marginal ulcers. Four patients developed clinical and radiologic evidence of recurrent ulceration. Three patients were treated for duodenal ulcer and one for marginal ulcer. All three patients treated for duodenal ulcer were treated with the Billroth I procedure; there were no marginal ulcers in patients treated for gastric or duodenal ulcer following use of the Billroth II procedure. (Table II.) As noted previously, this finding has led us to abandon the Billroth I procedure, for the incidence of marginal ulcer in this series (13 per cent) is almost identical with the incidence in a larger group of patients treated by the Billroth I procedure for other complications of duodenal ulcer [7].

TABLE III
ACUTE GASTRODUODENAL ULCERATION, POSTGASTRECTOMY SYMPTOMS*

Syndrome	Degree of Symptoms			Total	
	Mild	Moderate	Severe	No.†	Per cent
Dumping	20	6	0	26	35.6
Afferent loop obstruction	0	0	2	2	2.7
Psychoneurosis	2	1	1	4	5.4
Total	22	7	3	32	43.7

* Postgastrectomy symptoms occurred in thirty-two of seventy-three patients with benign ulceration.
† Figures in this column represent the number of patients.

Postgastrectomy symptoms of some type were present in 43.7 per cent of the patients, but in most instances the symptoms were mild. No patient developed a severe dumping syndrome. (Table III.)

Other factors to be considered in the evaluation of results are the patients' ability to maintain or gain weight and their ability to engage in a gainful occupation. Eighty-one per cent of the patients for whom accurate data were available had maintained or gained weight, and 83 per cent were working. For some of the patients who had lost weight, weight loss was desirable due to preoperative obesity; and in some instances of patients who were not working, the failure to work was not related to the postgastrectomy state but to other factors. For example, one patient, sixty-eight years of age, had retired several years prior to the time his gastrectomy was performed and did not return to work, while others had associated diseases which prevented gainful employment.

After considering all of these factors, the results were classified as excellent, good or poor. The per cent of patients who were classified as having good or excellent results was 87.7. (Table IV.)

TABLE IV
ACUTE GASTRODUODENAL PERFORATION, RESULTS FOLLOWING GASTRECTOMY*

Result	No. of Patients	Per cent
Excellent	44	60.3
Good	20	27.4
Poor	9	12.3
Total	73	100.0

* These are late results following immediate gastrectomy.

A review of the nine patients classified as poor results will give a more accurate picture of their problems. The three patients treated for duodenal ulcer, in whom recurrent ulceration developed following the Billroth 1 gastrectomy, had had ulcer symptoms for three, eight and fourteen years, respectively. One patient was operated upon in 1955. In 1957 pain and roentgenographic evidence of marginal ulcer developed. He was successfully treated by medical therapy and was asymptomatic when last seen in 1959. The second patient underwent gastrectomy in 1956 and one year later symptoms of pain as well as roentgenographic evidence of marginal ulcer developed. He was treated conservatively and the immediate result was good; there was, however, subsequent recurrence of symptoms, and in January 1960, he had an episode of gastrointestinal bleeding and intestinal obstruction. He was treated by lysis of adhesions and vagotomy.

In the third patient pain and roentgenographic evidence of marginal ulcer developed within five months following his operation in 1957. He responded promptly to hospitalization and medical therapy and was asymptomatic when last seen. The fourth patient, who had recurrent ulceration, was treated for a perforated marginal ulcer in June 1956, after having had a previous gastric resection in 1951 and a transthoracic vagotomy in 1952. In July 1956, obstruction and hemorrhage developed. At the time of reoperation, a malignant islet cell tumor of the pancreas was found, with metastases to regional nodes, in addition to a large marginal ulcer. Following resection of the body and tail of the pancreas, the involved lymph nodes, a re-resection of the stomach and a subdiaphragmatic vagotomy, the patient has remained achlorhydric and no evidence of marginal ulcer has been observed. This was the first patient with the Zollinger-Ellison syndrome treated in this hospital [8]. In a fifth patient, also treated by a Billroth 1 gastrectomy for duodenal ulcer, symptoms developed in the postoperative period which were suggestive of marginal ulcer; but this diagnosis could never be proved, and complications of hemorrhage, perforation or obstruction never supervened. Nevertheless, his abdominal pain was of sufficient severity to interfere with his normal activities.

The sixth patient with an unsatisfactory result has severe psychiatric problems requiring

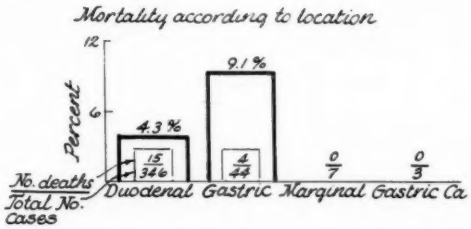

FIG. 4. Illustrated above is the mortality according to site of ulceration.

institutional psychiatric therapy; he is completely incapacitated. The symptoms are not those of marginal ulceration, nor has there ever been radiographic or gastroscopic evidence of marginal ulceration. Nevertheless, his symptoms are related to the gastrointestinal tract; and though they are believed to be psychiatric in origin, we consider him a poor result. The seventh patient has a similar problem. Although the psychiatric complaints are less severe than those of the previous patient, they are of sufficient magnitude to interfere with his normal activities. The remaining two patients had chronic afferent loop obstruction. Both of these patients have been discussed previously [12]. Each patient was treated by reoperation and both have been well during the five years since surgical relief of their afferent loop obstructions.

Consequently, during this period of follow-up, there has been only one patient who has required further surgery specifically for ulcer disease; it has been possible to relieve symptoms in five of the nine patients (three by subsequent surgery and two by a medical program). Thus, at the present time, there are only four patients (4.1 per cent) who are classified as persistently poor results.

Three patients have died in the late postoperative period, but the causes of their deaths were not related to recurrent ulceration or to complications of their operation.

COMMENTS

An analysis of other factors related to mortality shows agreement with previous reports. The mortality rate following treatment of gastric ulcer is higher than that following treatment of duodenal ulcer. (Fig. 4.) Also, the great majority of the deaths occur in patients who are treated more than twelve hours after perforation has occurred. The low mortality rate for patients treated within the first twelve hours

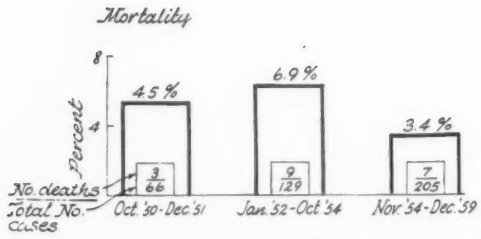

FIG. 5. This figure compares the total operative mortality in three periods between October 1, 1951 and December 31, 1959.

is largely because there has been limited time for exudation of fluid and electrolytes into the abdominal cavity and limited time for intestinal distention to ensue, and because purulent peritonitis has not developed. It would appear, however, that occasionally the significance of the relation between mortality and the interval between perforation and surgery is misconstrued to mean that each patient should be rushed to the operating room as quickly as possible after perforation has occurred. As has been noted by many authors, adequate preoperative preparation is more important. If necessary, several hours may be used to correct fluid and electrolyte imbalance, to begin the administration of antibiotics and to relieve the patient's pain prior to the time the operation is performed. This approach will save more patients than rapid operations on poorly prepared patients.

With regard to the relative merits of simple closure and immediate gastrectomy, the evidence presented herein supports the concept that each of these modalities of therapy has definite indications, and that, when properly utilized, the performance of subtotal gastrectomy does not increase the total operative mortality rate. In fact, a comparison of the operative mortality rates for the three periods studied reveals that the lowest operative mortality rate has occurred in the most recent period when the relative proportion of patients treated by immediate gastrectomy was the highest. (Fig. 5.) It would appear that our institution of the program which we now employ has resulted in an actual decrease in the over-all mortality rate, for it is important to note that not only has there been no increase in the immediate operative mortality rate, but, in addition, there has been no late mortality attributable to the disease or complications of surgery. In most series of patients treated for perforated ulcer by simple closure, 2 to 3 per cent of the patients die of complications of their ulcer disease in the late postoperative period. Others die following subtotal gastrectomy performed later. Thus, a true estimate of the mortality of patients with perforated ulcers must include these late deaths as well as those occurring in the immediate postoperative period. When this comparison is made, the reduction in mortality by the program reported herein is even more striking. Therefore, we have reached the firm conclusion that immediate gastrectomy is the treatment of choice for any patient having acute perforation who has a long history of ulcer disease or who has had previous complications of the disease provided he is a good operative risk. Simple closure should be used whenever systemic or local factors would significantly increase the operative risk.

A group of patients in which there is special interest consists of those in whom there was no history of ulcer prior to the time perforation occurred. There is reason to believe that these patients are least likely to have recurrent symptoms after simple closure. However, we have performed resection regardless of the history of previous ulcer disease, believing that perforation in itself indicates a serious manifestation of ulcer disease. The number of patients being followed is still too small to allow final evaluation of this aspect of the problem, but at the present time ten of the fourteen patients followed (70 per cent) are classified as excellent results and four (30 per cent) are classified as good results. All of these patients have maintained their preoperative weight or gained weight in the postoperative period, and only one has the dumping syndrome. The symptoms of this patient are so mild that they do not, in our opinion, prevent him from being an excellent result.

SUMMARY

An analysis of 400 patients surgically treated for acute perforation of gastroduodenal ulceration has been presented. Two hundred seventy-seven patients were treated by immediate subtotal gastrectomy, with a mortality rate of only 2.2 per cent, while the mortality in 110 patients treated by simple closure was 10.9 per cent. During a period when immediate subtotal gastrectomy was used with increased frequency, the total operative mortality rate decreased.

This led us to the conclusion that immediate subtotal gastrectomy is the treatment of choice for patients with acute perforated gastroduodenal ulceration, unless some specific contraindication exists, such as associated severe disease, presence of shock or purulent peritonitis. The follow-up results indicate that immediate gastrectomy has given good or excellent results in 87.3 per cent of seventy-three followed patients with benign disease.

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DISCUSSION

E. Everett O'Neil (Boston, Mass.): Since surgery came of age, this controversy arose and it still exists. I believe it is better to have a whole patient with a simple closure than a patient with a beautifully performed resection who goes into shock during the procedure. There is only one exception to that rule and that is where there has been a suspicious lesion that obviously demands a resection.

Stanley O. Hoerr (Cleveland, Ohio): To concur with Dr. Jordan in regard to this, one has to agree that gastric resection is the optimal operation for chronic duodenal ulcer. We believe that vagotomy with pyloroplasty is the procedure of choice at the present time. His work emboldens me to think that for the next perforation we should do a vagotomy with pyloroplasty instead of a gastric resection.

I think this is an excellent study and there isn't any question that results like his indicate the group should go right on doing what they are doing. In speculating as to how they can achieve such a mortality rate which is spectacular in this situation, I think there is one simple little thing which is worth noting. The patients that I lose in resection for chronic duodenal ulcer are those with posterior penetration. These are not seen in acute perforation so that by and large the problem of difficult closure of the duodenal stump should not exist.

R. T. Shackelford (Baltimore, Md.): Dr. Jordan, these are the most convincing statistics that I have encountered. I think that if all surgeons, who are not doing this particular type of surgery every day, adopt a routine procedure of gastrectomy for perforated peptic ulcer, mortalities will increase considerably. In the first place, many of us are working in institutions which do not have facilities as excellent as those to which you have access. We do not have the trained teams to help us take care of the patients after operation. My philosophy of surgery in an acute emergency is to do the simplest thing that saves the life of the patient. My old chief, Dr. Finney, always used to say, "I would rather have a live dog than a dead lion." You don't need much blood; there is the possibility that you might not be able to get blood in a smaller institution on quick notice. Furthermore, most perforations in such instances are acute and you don't have the time to evaluate their general condition. For those reasons, I personally perform far more simple closures on patients with acute perforations

than gastrectomies. I reserve gastrectomy for perforated ulcers on young people who have had relatively brief perforation and when the stomach and duodenum are mobile and the resection can be performed easily. The only justification I have for that conclusion is that all of the patients on whom we performed simple closures of perforated peptic ulcers twenty years before, were reviewed and one third of these patients had had no symptoms during this period. Another third had symptoms sufficient to require medical care but not surgery; and the remaining third required a subsequent operation because of symptoms.

I am interested in your comment on the higher incidence of marginal ulcers following gastroduodenostomy. Drs. Hanrahan and Greenough reviewed all the cases of pyloroplasty performed in 1928 and 1929, which at that time was a popular operation for duodenal ulcer. They found about 200 such patients whom they could follow-up, and they were unable to find any instance of a marginal ulcer.

QUESTION: Have you operated on any infants?

GEORGE L. JORDAN: A two month old baby was one of our patients on whom immediate resection was performed. This infant had a massive bleeding ulcer at the same time the perforation occurred and the resection was performed then not because of the perforation but because of the massive hemorrhage.

QUESTION: How many of these operations have been performed by residents?

GEORGE L. JORDAN: Currently about 100 per cent are performed by residents. Originally when we started this program many of them were performed by senior members of the staff and the rest by residents who were supervised directly at the operating table by the senior members. However, currently we believe that our fourth year residents have had sufficient experience to perform these themselves.

In regard to the technical aspect, Dr. Hoerr is quite right. These operations are generally easy, technically, to perform. The ulcers are anterior and the slight edema which has occurred actually helps dissection rather than hinders it. About 12 per cent of these patients do have a posterior ulcer at the same time. They have two ulcers, an anterior one which is perforated and a posterior one that is penetrating. This, of course, makes it a little bit harder but we do not think it necessarily causes any complication. We do not perform this operation in the presence of pus in the abdomen. We do not worry about the early chemical peritonitis but, frankly, if pus is present we believe that one should perform a simple closure.

There is one other point I would like to mention and that concerns evaluating the patients before surgery. We believe that all patients should be evaluated before surgery. As we mentioned, our figures correspond to those of others; namely, that those patients operated upon within twelve hours of perforation have a better outlook than those operated on after twelve hours have passed. But it is much wiser to spend, if necessary, several hours preparing the patient for surgery rather than to rush him to the operating room the eleventh hour in order to operate within the first twelve hours. Operating upon the patient soon after he arrives at the hospital is not, to me, of any import. I have no hesitancy at all in spending four, five, six, twelve or, in rare cases, twenty-four hours preparing a patient for operation and evaluating him properly. Evaluations of all of these patients include the usual laboratory work and any indicated studies before they are taken to the operating room.

Hemigastrectomy and Vagotomy in the Treatment of Duodenal Ulcer

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IN 1946, we began to perform a conservative type of gastrectomy combined with vagotomy in the treatment of duodenal ulcer. Our first report, dealing with the early results of this operation, called hemigastrectomy with vagotomy, was given at a meeting of the American Surgical Association in 1951 [3]. In this preliminary survey, we indicated that we were favorably impressed by the early results, from both clinical and physiologic viewpoints. This impression has been reaffirmed in subsequent publications [4,6,8,9]. The physiologic effect of this operation upon the acidity of the gastric contents was such that we ventured to predict that it would give a high degree of protection against the ulcer diathesis and that it would stand the test of time in this respect. At present, our belief is the same, and while insufficient time has elapsed to permit final conclusions, we are of the opinion that hemigastrectomy combined with vagotomy is an effective operation for duodenal ulcer. This report is a summary of our experiences to date.

METHOD OF STUDY

In order to assay the physiologic effects of various operations for duodenal ulcer, we developed a method for studying the acidity of the gastric contents. Data were collected under fasting or basal conditions of study as well as after chemical and neurogenic stimuli, both before and after a variety of operations on dogs and on man. At first, the studies were extremely detailed. After sufficient experience was obtained to determine which observations were most significant, the procedure was simplified as much as possible. Thus, it consisted of a one hour collection of gastric contents under basal or fasting conditions followed by a one hour collection after a potent food stimulus (peptomized beef broth) which was subsequently followed by a two hour collection period (divided into two one hour aliquots) after vagal stimulation induced by insulin hypoglycemia. The average amount of hydrochloric acid in the gastric contents, expressed in milliequivalents per hour for normal subjects and for patients with duodenal and gastrojejunal ulcers, for each of the three conditions studied is shown in Figure 1. Note that the quantity of acid produced under basal conditions by patients with duodenal ulcers and those with gastrojejunal ulcers was twice that of normal subjects. It was also increased after stimulation by broth and in response to insulin. The latter was the most potent stimulus and the gastric contents of patients with duodenal ulcers contained more than twice as much

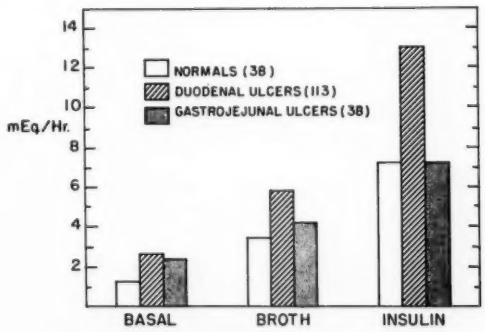

FIG. 1. Acidity of gastric contents (mEq./hr.).

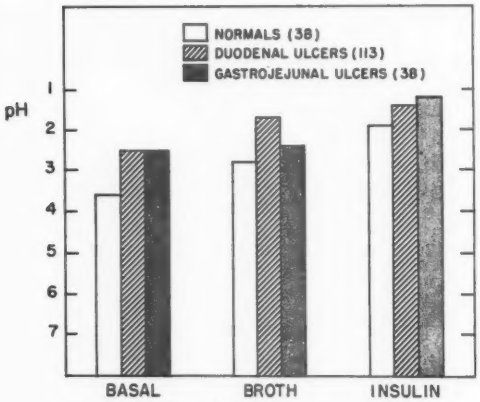

FIG. 2. Acidity of gastric contents (pH).

TABLE 1
EFFECTS OF VARIOUS OPERATIONS FOR DUODENAL ULCER ON GASTRIC ACIDITY*

Operation	No. of Patients	Free HCL Absent (pH 3.5 or more)
Gastrojejunal ulcers following various operations	18	0%
Gastrenterostomy with vagotomy	16	25%
Gastrectomy with vagotomy (⅓ removed)	6	50%
Gastrectomy (⅔ to ⅘ removed)	24	67%
Hemigastrectomy with vagotomy	10	80%
Gastrectomy with vagotomy (⅔ to ⅘ removed)	10	80%

* The effects were judged by the incidence of achlorhydria under fasting conditions of study and following stimulation by beef broth and insulin.

hydrochloric acid in response to insulin hypoglycemia than did those of normal subjects.

The average pH of the gastric contents of these same patients is shown in Figure 2. The most interesting finding with reference to the hydrogen ion concentration of the gastric contents was obtained from the normal subjects, as the average pH was above 3.5 in the basal state. In other words, free hydrochloric acid is absent under this condition of study. In response to stimuli, the pH falls significantly in all groups, the response being greater for patients with ulcers than for normal subjects, and maximal following insulin stimulation. The normal stomach, under basal conditions of study, has a respite from the digestive properties of the gastric contents since peptic activity is negligible when the pH is 3.5 or more. In response to stimulation, especially by insulin, the pH of the gastric contents falls to levels favoring maximal peptic activity.

The relation between the pH of the gastric contents and its peptic activity is illustrated in Figure 3. Peptic activity is maximal at a pH of 1.9. It is negligible at pH levels of 3.5 or more and disappears when the pH is 7. Peptic activity is less at pH 1 than at 1.9, but is much higher at pH 1 than at pH 3.5. The digestive capacity of the gastric contents is dependent upon its peptic activity. Free hydrochloric acid must be present in order to have a significant degree of peptic activity. When it is absent, peptic activity is negligible.

Our interest in the operation of hemigastrectomy combined with vagotomy was aroused initially because of its effect upon the acidity of the gastric contents. (Table 1.) We were impressed by the fact that a study of eighteen patients, who had developed gastrojejunal ulcers after various operations, failed to reveal a single patient whose gastric contents were achlorhydric (pH below 3.5) under our three conditions of study. Every patient had free

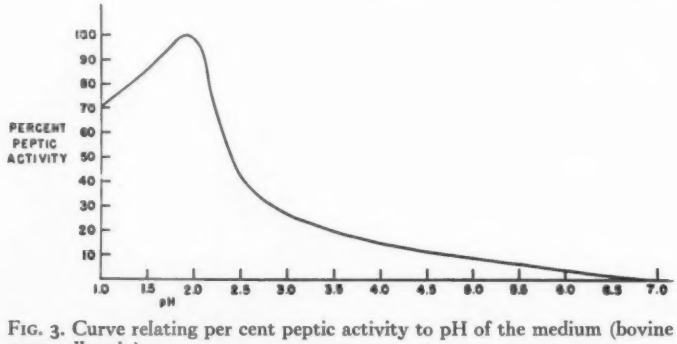

FIG. 3. Curve relating per cent peptic activity to pH of the medium (bovine serum albumin).

TABLE II
DUODENAL ULCER OPERATIVE DEATHS AND MORTALITY

Operation	Number of Patients*			Operative Deaths					Mortality
				Duodenal Stump		Other Causes		Total	
	<5 yrs.	5 to 13 yrs.	Total	No.	%	No.	%		
Hemigastrectomy with vagotomy	283	63	346	3	43	4	57	7	2.0
Subtotal gastrectomy	168	342	510	5	29	12	71	17	3.3

* These patients were treated at Massachusetts Memorial Hospitals and Providence Veterans Administration Hospital during the period of October 1946 to January 1960.

hydrochloric acid, and by inference, adequate peptic activity of the gastric contents occurred under one or all three conditions of study to permit recurrent ulceration. The response was maximal after insulin stimulation in virtually every subject. This finding naturally influenced our thinking regarding the probable efficacy of various operations in eradicating the ulcer diathesis. We believed that the most desirable operation in this respect was the one which produced the highest incidence of achlorhydria. Accordingly, small numbers of patients were subjected to various operations. The more important results are listed in Table I, together with the incidence of achlorhydria for each operation as judged by this method of study. Similar observations were also made in dogs. The results checked closely with those for man.

As indicated in Table I, sixteen patients were subjected to gastroenterostomy combined with vagotomy. Twenty-five per cent of these were achlorhydric. The distal third of the stomach was removed from six patients in an attempt to remove the antral factor. This was combined with vagotomy. Half of these patients were achlorhydric. At the time this study was instigated, subtotal gastrectomy was the customary operation for duodenal ulcer. A study of twenty-four patients after subtotal gastrectomy revealed that 67 per cent were achlorhydric. Ten patients were subjected to hemigastrectomy with vagotomy. Eighty per cent were achlorhydric. The findings were the same for ten patients, following subtotal gastrectomy combined with vagotomy. The removal of more than one half of the stomach did not seem to increase the incidence of achlorhydria. Since we were interested in preserving as much of the stomach as possible in order to minimize the frequency of untoward secondary side effects related to a small gastric remnant and at the same time achieve a maximal incidence of achlorhydria, we decided to develop a series of patients having hemigastrectomy with vagotomy and to continue our subtotal gastrectomy series for comparison. We did not feel justified in performing large numbers of gastroenterostomies combined with vagotomy because 75 per cent of the trial series were not achlorhydric. This meant that the eventual incidence of recurrent ulceration would probably be too high. Our attitude remains the same toward this operation and toward pyloroplasty combined with vagotomy, as well. The incidence of achlorhydria in the small groups of patients having either of these operations is, in our limited experience, too low to justify routine employment of these procedures. However, there is definitely a place for these operations, especially gastroenterostomy with vagotomy, when removal of the antrum is impossible or too hazardous because of the morbidity and mortality related to closure of the duodenal stump.

OPERATIVE MORTALITY

During the past thirteen years (Table II), we have performed 346 hemigastrectomies with vagotomy and 510 subtotal gastrectomies for duodenal ulcer. Other procedures such as gastroenterostomy or pyloroplasty with vagotomy [2,7] or hemigastrectomy with vagotomy

with exclusion of the distal portion of the antrum [*11*] were also carried out in comparatively small numbers of patients. The clinical and physiologic results of these operations are considered in a subsequent discussion.

The operative mortality was 2.0 per cent for hemigastrectomy and vagotomy. The operative mortality for subtotal gastrectomy was 3.3 per cent, and, although it was higher it was not significantly different. These percentages for operative mortality are in accordance with the average values, for large numbers of patients, collected from the literature. Operative mortality is the consequence of a number of factors. The age and general condition of the patient is important. The majority of the operations referred to in this discussion were performed under satisfactory circumstances by members of our resident staff with adequate supervision at either the Massachusetts Memorial or the Providence Veterans Administration Hospitals. While most of the operations were elective in nature, a significant number were performed in the presence of massive hemorrhage and, in a few patients, acute perforation had occurred. These two types of complications were more common among the veterans. Among the patients on whom elective operations were performed, marked pyloric obstruction and deformity were the most common findings. Those older patients who were poor risks were encountered more frequently in the Massachusetts Memorial Hospitals.

Generally speaking, the operative mortality following gastroenterostomy or pyloroplasty combined with vagotomy, as judged by statistics collected from the literature, is under 1 per cent [*2,12*]. This mortality rate appears to be that which is expected when these more conservative procedures are employed more or less routinely by capable surgeons. On the other hand, the mortality rate for gastroenterostomy alone or gastroenterostomy combined with vagotomy may be high even in the hands of an expert.

In this connection, the experience of Colp [*1*] is important. Over a nine year period, he performed 224 subtotal gastrectomies without vagotomy and 217 subtotal gastrectomies with vagotomy in the management of duodenal and gastrojejunal ulcers. The operative mortality was 0.4 per cent for subtotal gastrectomy alone and 0.9 per cent when combined with vagotomy. These mortality rates are extraordinarily low. During the same period, he employed gastroenterostomy alone in twenty-eight cases and combined it with vagotomy in seventy-three cases. The operative mortality for these 101 patients was 5 per cent. The explanation for this is that these lesser procedures were used on the patients who were poorer risks and when the management of a duodenal stump appeared unduly hazardous or impossible. In series in which there are significant numbers of elderly and poor risk patients, a certain operative mortality is inevitable. Colp's over-all mortality for his 542 patients was 1.5 per cent, which is about as low as it can be for comparable material. Our over-all mortality for 856 patients was 2.8 per cent. One third of these deaths were due to complications resulting from closure of the duodenal stump. If these had been avoided as they should and can be, the mortality would have been 1.9 per cent, or more nearly what it should be. In both of our series, there are runs of 100 or more consecutive patients with no operative deaths. Most of our remaining deaths were due to cardiovascular and pulmonary complications which might well have occurred regardless of the operation performed. We used the Billroth II operation in over 95 per cent of patients with a Hofmeister type of anastomosis. About 75 per cent of the anastomoses were antecolic. In the subtotal gastrectomy series, the amount of stomach removed was estimated to range from 60 to 80 per cent.

CLINICAL RESULTS

The clinical results in patients of one to thirteen years have been divided into four categories; excellent, good, fair (all of which are regarded as acceptable) and poor. (Table III.) Excellent means perfect and the patient is entirely asymptomatic. Good means some minor digestive complaint and fair means definite secondary side effects which are not disabling and are regarded by the patient as less troublesome than his preoperative symptoms. Patients with poor results either have severe symptoms resulting from the operation, such as the dumping syndrome, nutritional problems or digestive disturbances which are as bad or worse than the original symptoms but without evidence of recurrent ulceration. In addition, all cases with proved gastrojejunal ulcers are classified as poor results. The percentage of good plus fair results were essen-

tially the same in the two series. There were more excellent and fewer poor results in the series of patients who had hemigastrectomy with vagotomy. This smaller percentage of poor results is due to a much lower incidence of stomal ulceration and of severe secondary side effects as well. It should be mentioned that, as indicated in Table II, a larger number of patients having subtotal gastrectomy have been followed for five to thirteen years because, in the early years of this study, we increased the number of patients in the hemigastrectomy and vagotomy series rather slowly. In recent years, we have performed many more hemigastrectomies with vagotomy because the results are superior. In 1959, for instance, we employed hemigastrectomy and vagotomy in ninety-eight patients and subtotal gastrectomy in twenty-one patients. The longer follow-up for larger numbers of patients having subtotal gastrectomy would not effect the percentage of poor results materially which were not related to recurrent ulceration.

TABLE III
CLINICAL RESULTS OF TREATMENT FOR DUODENAL ULCER

Operation	No. of Patients*	Time Followed (years)	Clinical Results (per cent)†			
			E	G	F	P
Hemigastrectomy with vagotomy....	213	1 to 13	29	42	24	5
Subtotal gastrectomy	458	1 to 13	17	36	28	17

* See footnote to Table II.
† E = excellent, G = good, F = fair and P = poor.

STOMAL ULCERS

Three stomal ulcers have developed in patients in the hemigastrectomy and vagotomy series and in twenty-six in the subtotal gastrectomy group, an incidence of 1.4 per cent and 5.7 per cent, respectively, for cases followed one to thirteen years. (Table IV.) All three of the former developed ulcers during the third postoperative year. There has been no ocurrence of gastrojejunal ulcers among the hemigastrectomy and vagotomy patients operated upon five to thirteen years ago. Twenty-one of the twenty-six stomal ulcers in the subtotal gastrectomy group occurred in the first five years; three developed within a year of operation. Five of the twenty-six gastrojejunal ulcers occurred five years or more after subtotal gastrectomy.

STOMAL ULCER VERSUS ACIDITY OF GASTRIC CONTENTS

I would like to discuss this matter of recurrent ulceration in relation to the physiologic effect of operation. The number of stomal ulcers which have developed in all patients in both series, who have had complete studies of gastric acidity following operation, are given in Table V. These include patients studied within a year after operation. For this reason, the totals are different from those given in Table IV. Also, it is apparent that a somewhat higher percentage of patients who have had hemigastrectomy with vagotomy have been studied postoperatively than is the case in the subtotal gastrectomy group. This is not an attempt to establish the over-all incidence of stomal ulcers but to consider them in relation to the physiologic effect of these operations upon the acidity of the gastric contents. As we have followed these patients over the years, many have had numerous check-up secretory tests. While occasional exceptions have been noted, the general rule is that if a patient is achlorhydric in the early

TABLE IV
OCCURRENCE OF STOMAL ULCERS AFTER OPERATION FOR DUODENAL ULCERS

Operation	No. of Patients*	Time Followed (years)	Onset After Operation (years)								Total No.	Per cent
			<1	1	2	3	4	5	6	7		
Hemigastrectomy with vagotomy.....	213	1 to 13	0	0	0	3	0	0	0	0	3	1.4
Subtotal gastrectomy.....	458	1 to 13	3	5	5	6	2	1	2	2	26	5.7

* See footnote to Table II.

TABLE V

STOMAL ULCER VERSUS ACIDITY OF GASTRIC CONTENTS*

Operation	No. of Patients*	Total No. of Stomal Ulcers	Condition of Study of Gastric Contents			
			Free HCL (insulin)		No. Stomal Ulcers	Per cent
			(%)	(no.)		
Hemigastrectomy with vagotomy	277	3	Present = 17	48	3	6.2
			Absent = 83	229	0	0.0
Subtotal gastrectomy	306	20	Present = 33	103	20	19.6
			Absent = 67	203	0	0.0

NOTE: Data were obtained after indicated operations for duodenal ulcer.
* See footnote to Table II.

days or weeks after operation, he continues to be so indefinitely.

There were three stomal ulcers among 277 patients who have had hemigastrectomy with vagotomy and twenty among 306 patients who were subjected to subtotal gastrectomy and secretory study. If we divide the patients into two categories, those with achlorhydria and those with free acid (insulin), it is apparent that 83 per cent of the patients are achlorhydric after hemigastrectomy with vagotomy and 67 per cent are achlorhydric following subtotal gastrectomy. Reference to Table I shows that these percentages for both operations are virtually identical with those quoted for ten to twenty-four patients who were carefully studied in the early part of this investigation. If we consider the achlorhydric patients after either operation, we find that there was no occurrence of jejunal ulcers following 229 hemigastrectomies with vagotomy or 203 subtotal gastrectomies. In other words, no jejunal ulcers have developed in 432 patients with achlorhydria on insulin stimulation, the most searching of our three conditions of study. On the other hand, among nonachlorhydric patients three jejunal ulcers occurred following forty-eight hemigastrectomies combined with vagotomy and stomal ulcers have developed so far in twenty of the 103 patients who have had subtotal gastrectomy with free acid, an incidence of 6.2 per cent and 19.6 per cent, respectively. These data abundantly confirm our original impression that all patients with gastrojejunal ulcers have free hydrochloric acid in their gastric contents under our conditions of study and that if free hydrochloric acid is absent, stomal ulceration will not occur. Although our experience with lesser operations is quantitatively small, the same findings hold. It would, therefore, seem highly probable that regardless of the operation performed, if achlorhydria as we have defined it exists, recurrent ulceration will not take place. Only patients with free hydrochloric acid (pH below 3.5) under fasting conditions of study or in response to a food stimulus (broth) or especially in response to insulin hypoglycemia will develop recurrent ulceration.

ACIDITY OF GASTRIC CONTENTS

We are fully aware of the fact that all patients with free acid after one operation or another do not develop recurrent ulceration. So far as we know, just which patients these are has never been defined. In an attempt to cast some light on this question, we have compared (Table VI) the quantity of hydrochloric acid in the gastric contents of fifty-three patients with stomal ulcers to that of seventy-nine nonachlorhydric patients after subtotal gastrectomy and to forty-five patients with free acid following hemigastrectomy with vagotomy, none of whom have as yet developed recurrent ulcers. At the other extreme are 432 patients who are achlorhydric following either of these operations and who have not and, we confidently believe, will not develop stomal ulcers. Note that there is a wide variation in the quantity of hydrochloric acid in the gastric

TABLE VI

ACIDITY OF GASTRIC CONTENTS*

Operation and Acidity	No. of Patients†	mEq. HCL/hr. (insulin)		
		0 (%)	0.03–0.3 (%)	0.4–25.4 (%)
Stomal ulcers				
After various operations	53	0	0	100
Subtotal gastrectomy				
With free acid; no ulcers (as yet)	79	0	14	86
Hemigastrectomy with vagotomy				
With free acid; no ulcers (as yet)	45	0	34	66
Hemigastrectomy with vagotomy and subtotal gastrectomy				
No free acid; no ulcers	432	0	0	0

* A comparison of stomal ulcer patients and patients with and without free acid but without stomal ulcers after hemigastrectomy with vagotomy or subtotal gastrectomy for duodenal ulcers.

† See footnote to Table II.

contents of the patients with stomal ulcers (expressed in milliequivalents per hour), following stimulation by insulin, ranging from an extremely low figure of 0.4 to a very high value of 25.4. When one realizes that the average value for normal subjects under these circumstances is 7.2, it is apparent that reducing the quantity of hydrochloric acid in the gastric contents to within the normal range is no assurance against recurrent ulceration. It is apparent that 86 per cent of the patients, who have had subtotal gastrectomy, and 66 per cent, who have had hemigastrectomy with vagotomy, with free acid but without recurrent ulceration as yet have gastric acidities in the same range as those of patients with stomal ulcers (0.4 to 25.4) and theoretically can develop gastrojejunal ulcers. So far, no stomal ulcer has developed in a patient with an output of less than 0.4 mEq. hydrochloric acid and the smallest quantity of hydrochloric acid in the gastric contents of a nonachlorhydric patient without an ulcer is 0.03 mEq. per hour. Thus, the safe range for patients with free acid would appear to be 0.03 to 0.3 mEq. per hour. Only 14 per cent of the patients who have had subtotal gastrectomy and 34 per cent of those who have had hemigastrectomy with vagotomy fall in this range. The values in this range are small and approximate zero. The 432 achlorhydric patients produced no free hydrochloric acid. On the basis, then, of quantity of acid produced, one might say that to be fully protected against recurrent ulceration, the gastric contents must be achlorhydric or contain less than 0.4 mEq. hydrochloric acid per hour on insulin stimulation.

As another index of degree of acidity of the gastric contents which can be tolerated and which would appear to be low enough to protect against recurrent ulceration, we have compared the hydrogen ion concentration in the gastric contents of these same groups of patients. In Table VII, the pH range of the gastric contents has been divided into three zones. The pH range of the fifty-three patients with stomal ulcers, 2.6 to 1.0, defines the zone of highest acidity. To date, no stomal ulcer has occurred in a patient with a pH level above 2.6. At the other extreme are the 432 achlorhydric patients with pH levels of 3.5 or more, thus leaving an intermediate zone of 3.4 to 2.7. This is a narrow zone which so far has not been invaded by a patient with stomal ulcer and, to date, no patient with free hydrochloric acid of this order of magnitude has as yet developed recurrent ulceration following subtotal gastrectomy or hemigastrectomy combined with vagotomy. It should be noted that 14 per cent of the former and 34 per cent of the latter fall into this so far free acid zone (3.4 to 2.7). The great majority of nonachlorhydric patients after either of these operations, 81 per cent and 66 per cent, respectively, are contained in the dangerous zone, pH 2.6 to 1.0 (where the fifty-three patients with stomal ulcers are), and theo-

TABLE VII
ACIDITY OF GASTRIC CONTENTS*

Operation and Results	No. of Patients†	pH (insulin)		
		3.5 or more (%)	3.4–2.7 (%)	2.6–1.0 (%)
Stomal ulcers				
After various operations	53	0	0	100
Subtotal gastrectomy				
With free acid; no ulcers (as yet)	79	0	19	81
Hemigastrectomy with vagotomy				
With free acid; no ulcers (as yet)	45	0	34	66
Hemigastrectomy with vagotomy and subtotal gastrectomy				
No free acid; no ulcers	432	100	0	0

* A comparison of stomal ulcer patients and patients with and without free acid but without stomal ulcers after hemigastrectomy with vagotomy or subtotal gastrectomy for duodenal ulcer.

† See footnote to Table II.

retically could develop recurrent ulceration. Time alone will tell how many will.

EFFECTIVE PEPTIC ACTIVITY OF GASTRIC CONTENTS

In the early years of this investigation, our study of the gastric contents consisted of determining its acidity under basal conditions and following stimulation by broth and insulin as described. In more recent years, we have also determined the amount of pepsin in the gastric contents under the same conditions of study. The average values for normal subjects and for patients with duodenal ulcers and gastrojejunal ulcers, expressed as the effective peptic activity of the gastric contents, are shown in Figure 4. The effective peptic activity of the gastric contents is arrived at by a calculation which involves the pepsin concentration in units per cc., the volume in cc. per hour and the effective peptic activity as modified by the pH of the gastric sample in units per hour. The findings emphasize the importance of the vagus nerves in regulating the peptic activity of the gastric contents. Potent food stimuli have no important effect on the output of pepsin by contrast to their effect upon the secretion of hydrochloric acid. As previously mentioned, the digestive capacity of the gastric contents is in the final analysis due to its effective peptic activity.

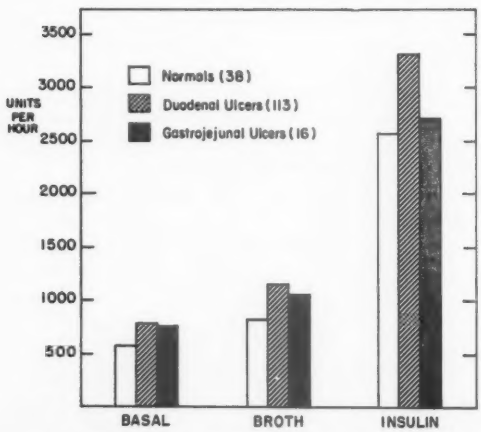

FIG. 4. Effective peptic activity of gastric contents.

The method of study used for determining effective peptic activity is briefly as follows: volume is recorded directly, and the pH of each aliquot is detected with a Beckman pH meter. Units of free hydrochloric acid are titrated electrometrically to a pH of 3.5. Total milliequivalents of free acid for an hour are then calculated as follows:

$$\text{Total milliequivalents free HCL} = \frac{\text{units of free HCL} \times \text{volume}}{1{,}000}$$

Representative samples of each aliquot are then combined to give single specimens for the basal and broth tests and for that hour of the insulin test during which most acid was produced. These are then subjected to determina-

TABLE VIII
EFFECTIVE PEPTIC ACTIVITY (E.P.A.) OF GASTRIC CONTENTS*

Operation and Results	No. of Patients†	E.P.A. Range in units/hr. (insulin)			
		0–153 (%)	154–416 (%)	417–999 (%)	1,000–5,575 (%)
Stomal ulcers					
After various operations	26	0	0	31	69
Subtotal gastrectomy					
With free acid; no ulcers (as yet)	9	11	22	33	34
Hemigastrectomy with vagotomy					
With free acid; no ulcers (as yet)	40	40	15	30	15
Hemigastrectomy with vasotomy and subtotal gastrectomy					
No free acid; no ulcers	200	100	0	0	0

* A comparison of stomal ulcer patients and patients with and without free acid but without stomal ulcers after hemigastrectomy with vagotomy or subtotal gastrectomy for duodenal ulcer.
† See footnote to Table II.

tion of peptic activity using a photometric method. The method employed is that described by Tomarelli, Charney and Harding [10]. As modified in this laboratory, it is possible to measure the velocity constant of the digestion of a diazotized bovine albumin substrate (Fraction V., Armour & Co.) by the pepsin present in the gastric contents buffered to a point of maximum activity for the substrate [7]. Results are obtained in pepsin units per cc., pepsin units per hour and effective peptic activity as modified by the pH of the gastric sample [5].

While the number of observations we have made to date on the effective peptic activity of the gastric contents is small by comparison with our data on acidity, they appear to be of importance and are just beginning to assume significance. With regard to this question of what is a safe zone in which peptic ulceration will not recur among patients having free acid postoperatively, this would appear to offer a better index than data just referred to regarding the quantity of free acid or the pH of the gastric contents.

The data which we have so far accumulated on this point are summarized in Table VIII. The effective peptic activity range is divided into four zones as measured in units per hour following stimulation by insulin. The higher zones were arbitrarily selected on the basis of the finding in the twenty-six stomal ulcer cases in which this data were available. The zone of highest effective peptic activity, 1,000 to 5,575, contains 69 per cent of the cases of stomal ulcers and that of 417 to 999 contains 31 per cent. To date, the lowest effective peptic activity within any patient with stomal ulcer is 417. At the other extreme are 200 achlorhydric patients who have had subtotal gastrectomy or hemigastrectomy with vagotomy. The highest effective peptic activity of any of these patients was 153; in fact, the effective peptic activity of 198 of these 200 patients was below 100 and in many it was zero. Thus the lowest zone is defined as 0 to 153. This leaves what might be called a buffer zone of 154 to 416 which has not been invaded as yet by either a patient with stomal ulcer or an achlorhydric patient. The probability is that patients with free hydrochloric acid postoperatively, who have an effective peptic activity in this range, will have a high degree of protection against recurrent ulceration. Postoperative cases with free acid and effective peptic activity in the 0 to 153 zone should be completely protected. The combined range of these two safe zones, 0 to 416, is wider comparatively speaking than those we have been able to define on the basis of milliequivalents of free hydrochloric acid or the pH of the gastric contents. It contains 33 per cent of nine nonachlorhydric patients after subtotal gastrectomy and 55 per cent of forty patients who have had hemigastrectomy with vagotomy. Thirty-three per cent of the former and 30 per cent of the latter are in the 417 to

999 zone in which the eventual incidence of recurrent ulceration will undoubtedly be much lower than among the 34 per cent of the former and 15 per cent of the latter in the highest zone, 1,000 to 5,575. This zone contains 69 per cent of the patients with stomal ulcers. Thus it would appear that patients having free hydrochloric acid postoperatively are protected against recurrent ulceration if the effective peptic activity of their gastric contents is below 417 units per hour in response to insulin hypoglycemia.

SUMMARY

The results of hemigastrectomy combined with vagotomy are superior to those of subtotal gastrectomy from every viewpoint, in our experience. These two procedures have been compared on the basis of operative mortality, clinical results, frequency of recurrent ulceration and the physiologic effect on the acidity and effective peptic activity of the gastric contents. We believe that hemigastrectomy with vagotomy is a very effective operation and we employ it as the procedure of choice in the treatment of duodenal ulcer.

With regard to more conservative procedures, our own experience with them does not permit an accurate comparison at this time. We will discuss this matter at a later date. So far as one can judge from a comprehensive survey of the literature, lesser procedures such as vagotomy combined with gastroenterostomy or pyloroplasty are reported to have an operative mortality which is lower by about 1 per cent [2,12]. On the other hand, as we have indicated, if one has to deal with significant numbers of patients who are poor risks, the operative mortality for the most conservative procedures may be as high as 5 per cent [1]. They certainly should be used when closure of the duodenal stump is hazardous. Whether the operative mortality in other patients who are poor risks will be lowered or not is open to some question.

We find no evidence in the literature [2,12] or in our own limited experience that the clinical results of lesser procedures are superior to those of hemigastrectomy with vagotomy.

With regard to recurrent ulceration, there is no doubt that the results of lesser procedures are inferior. On the basis of the physiologic effect of these operations, on the acidity and peptic activity of the gastric contents, we suspect that the eventual outcome of these operations will be disappointing and that the morbidity and mortality related to recurrent ulceration will more than counterbalance unfavorably the questionable advantage of these procedures in terms of initial operative mortality.

Insofar as we can judge from the literature, the recurrence rate for vagotomy with gastroenterostomy or pyloroplasty among patients followed for a period comparable to those for patients discussed in this report varies from 5 to 10 per cent. The experience of Colp [1] seems pertinent in this regard. In a 1 to 9 year follow-up period, recurrent ulcers developed in 0.5 per cent of his patients following subtotal gastrectomy combined with vagotomy, in 7.7 per cent of patients following subtotal gastrectomy, in 10 per cent of his patients following gastroenterostomy combined with vagotomy and in 15 per cent of his patients having gastroenterostomy alone.

With regard to the physiologic aspects of this problem, which we believe will eventually prove to be most important, our data permit certain statements regarding the question of which patients will develop recurrent ulceration following various operations. We think that this is an important matter since, so far as we know, the purpose of an operation for duodenal ulcer is to cure the ulcer and prevent its recurrence.

On the basis of our physiologic evidence to date, we can say the following. (1) No patient, whose gastric contents are achlorhydric under basal conditions of study and in response to stimulation by peptomized beef broth and insulin (pH 3.5 or more), has had a recurrent ulcer. (2) All patients with recurrent ulceration have free hydrochloric acid in their gastric contents under one or all of the above conditions of study (pH below 3.5). (3) Patients with free hydrochloric acid in their gastric contents following stimulation by insulin, who appear to be protected against recurrent ulceration, are contained within the following categories: (a) The quantity of free hydrochloric acid expressed in milliequivalents per liter is in the range 0.03 to 0.3. (b) The acidity of the gastric contents is in the range pH 3.4 to 2.7. (c) The effective peptic activity of the gastric contents is below 417 units per hour.

Data concerning the acidity and effective peptic activity of the gastric contents permit the evaluation of parietal and chief cell activity

separately and would appear to open new areas of the peptic ulcer problem to exploration.

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SCIENTIFIC PAPERS

The Changing Emergency Ward

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THE emergency ward has become an essential part of our community. To the acutely ill or severely injured it may be of vital importance. The progressive change in services provided by this hospital facility in the last three decades has been so remarkable that its successful management is now a greater challenge to hospitals and the medical profession than ever before.

To study the scope of the services provided in emergency wards in the United States a questionnaire [1] was sent to 6,786 hospitals requesting information as to the number of emergency patients seen in the year 1958. The 3,799 hospitals responding reported 17,980,226 emergency visits. Of this total 1,842,559 patients were admitted to the hospital. These figures represent only a portion of the national total.

The rapid increase in patient load in one emergency ward is illustrated in a report of The Hartford Hospital [2] in Connecticut where emergency treatments rose from 3,000 in 1944 to 18,000 in 1955. At St. Luke's Hospital [3] in Cleveland, 10,209 patients received treatment in the Emergency Department in 1944 as compared with 26,821 in 1955. The experience of these two hospitals is similar to that of many others throughout the United States.

We propose to discuss some of the administrative, medical and legal problems which confront emergency departments today. It is also our purpose to try to analyze what the individual citizen has come to expect from his community emergency ward and what his obligation should be. Is he expecting too much? Are we offering too little? Why have many people been so critical of service, treatment and other functions of the department? What has caused them to carry chips on their shoulders to the emergency admitting department where in many instances patients are overwrought, hyperreactive and even belligerent when the service does not meet their expectations? Why are critical letters to hospital administrators on the increase? Why are there demands for money damages by the disgruntled and why the rash of law suits?

We consider these problems from the point of view of the physician, the hospital administrator and the lawyer, and hope to offer constructive criticism to all hospitals and to the professions involved. It is also our purpose to consider the viewpoint of the citizen who may be abusing a service which has been set up to aid him. In nearly all instances the emergency ward is operated at a financial loss by the hospital and, therefore, is indirectly a community liability.

In 1956 Shortliffe et al. [2] surveyed ninety hospitals of from 150 to 1,000 bed capacity. In almost fifty per cent of these hospitals the increased use of the emergency department was attributed to the difficulty in finding a physician at night, on week ends and holidays, and recognition by the public that the hospital was open at all times.

Other causes (mentioned in decreasing order) were increase of accidents (mainly automotive), use by physicians of the emergency ward for treatments formerly performed in their offices, third party payment for emergency room care

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(predominently industrial and insurance), population growth, and the patient's desire to economize by bypassing the doctor's office. The shortage of hospital beds was also thought to have had some effect on the emergency load. The order of frequency of these causes varied, depending on the location of the hospital and its particular demands.

Patients who present themselves for consultation and care which does not require immediate attention account for some of the increased load of the emergency department. The care of these patients may interfere with proper care of patients requiring emergency treatment. The fact that many of these departments are continuously open and staffed, conveniently located, and take reasonably prompt care of the patient, is more attractive to some non-emergency patients than a physician's private office.

Emergency departments generally have elaborate facilities for emergency care including the use of x-ray and laboratory equipment, and patients have been educated to expect these services. Third party payers and insurance companies also tend to increase this load since the proof of claim may depend on x-ray examination or laboratory procedure. Hospital administrators and physicians in the emergency ward are reluctant to refuse these services in fear of overlooking some disease or injury which is not otherwise apparent. Physicians who are faced with such a situation tend to err on the side of excessive diagnostic work and treatment. Patients are surprisingly aware of what they call their "insurance privileges" and "legal rights" and, as a result, tend to over assert themselves in the emergency department.

The public has gained a peculiar concept as to what these rights are and what they feel they can expect in the way of service. The status of the hospital, on the other hand, is not clear. None of the parties involved has a definite concept as to what privileges, obligations and so-called rights the hospital, the patient, and the physician actually do have. It would seem to us that the physician should prescribe and advise for the patient who comes to the emergency ward. The patient's interest should be to get well and not the financial gain he may obtain from his injury over and above compensation for his medical expense and loss of time from work. Every physician has treated patients who looked for medical errors from which they hoped to benefit financially. In some instances such persons may have been enticed into this position by outside influences. Emergency departments are a fertile field for "ambulance chasers."

The legal aspects of emergency wards are becoming an ever increasing problem to those concerned with the handling of these patients. We will therefore mention briefly some legal considerations which have a direct bearing on this department.

In most states it is doubtful whether an emergency applicant in private and charitably supported hospitals has a legal right to demand that he be admitted and treated. However, Illinois [*4*] has a statute which requires any hospital "where surgical operations are performed" to give emergency medical treatment or first aid to any applicant who applies in case of an accident or injury which is liable to cause death or severe injury. In New York [*5*] "any public hospital" is under a similar statutory duty.

Some hospitals are supported in whole or in substantial part by municipal, county or state governments. These are usually required, either by state law, municipal ordinance or contract, to admit persons who are residents of, or found injured, or sick, in the contributing government's geographic area.

No individual, whether resident or transient, who requires immediate treatment of an injury is going to be left at the door while the hospital administrator calls the lawyer to determine whether or not the applicant can be admitted. To consider this as a serious question seems ludicrous, but only because the public has become accustomed to the existence and service of the emergency ward.

At common law [*6*] a physician had no legal obligation to go to the assistance of any sick person. An Alabama court has decided that a hospital did not have a legal duty to accept an emergency room applicant when the applicant had a contagious disease and there was no contagious disease ward in the hospital [*7*]. However, legal responsibilities begin as soon as the emergency room personnel begin their treatment of the applicant [*8*].

It is beyond the scope of this paper to discuss the basis of tort liability imposed upon hospitals for the allegedly negligent conduct of the hospital and medical staff personnel. Generalities in this field are impossible because different

theories of law apply in different states and to different types of hospitals. This question is continually before the reviewing courts and concepts of legal duty and responsibility are changing [9].

However, the hospital's legal responsibility for incidents occurring in the emergency room is that the hospital is under a legal duty to exercise reasonable care over the emergency room applicant. It must never be forgotten that it is a jury of laymen rather than a board of physicians, who will ultimately determine whether or not that conduct has been reasonable in most cases.

The interpretation of what constitutes "reasonable care" of the emergency room applicant varies with the circumstances. Also it must not be forgotten that the interne or resident physician and, in exceptional cases, the staff or attending physician may be held legally responsible for any act or failure to act toward the emergency ward patient the same as he is toward any patient.

One complex problem encountered by personnel in the emergency department is making the decision as to whether or not emergency treatment is necessary in each instance and to decide who shall be treated and who shall be turned away. This requires experience and diplomacy and also creates legal questions. While recognizing that there are some legal risks we believe that the decision of the physician in charge must be final and supported by his hospital.

People in the community should be encouraged to believe that they can rely on the physician's judgment and not immediately question the decision that treatment can be deferred. When a patient is turned away he often believes that he has been mistreated or neglected. This can be avoided, to some degree, by providing the calibre of medical personnel who merit the confidence of these applicants. In addition to a well trained physician in charge, intelligent and pleasant receptionists are essential. Experienced nurses and orderlies are also of paramount importance. Personnel in the emergency ward must make sure that the patient who has been turned away is diplomatically convinced that the type of treatment he requests is not a function of an emergency department.

Other factors have made the treatment of emergency patients difficult. For example a group of "medical authorities" has been created by educational programs, first aid courses, newspaper and magazine information, and similar sources. This is good and bad. It is good if the knowledge is used with discretion and bad if lay interference hinders sound treatment. In medicine, as elsewhere, a little knowledge is sometimes a dangerous thing.

Many things have been done to bring community emergency departments to the fore. The citizen is instructed and encouraged to go immediately to the hospital when an emergency arises. Police ambulances, fire department emergency trucks, and first-aid or emergency cars take patients directly to the hospital since physicians' offices rarely have facilities for extensive emergency care.

Some industrial plants which formerly had elaborate first aid facilities with well trained physicians available now find it more convenient and possibly cheaper to send their patients to the nearest hospital emergency department. First aid stations in plants were often treating not only emergencies, but everything medical. The demands of organized labor have also increased the use of these departments. In some instances the industry found itself in the position of practicing medicine and has been relieved to pass the problem on to the hospital.

Certain insurance companies have oversold their policies or made unreasonable promises as to what the patient may expect in the way of emergency or other treatment. As a result patients come to the department with a minor problem and request and expect special procedures that are unrelated to their actual complaint in the belief that they are "covered." If the person is accommodated, the work load of the staff as well as the waiting time of other patients is increased.

Economic problems arise when the insurance company or prepayment plan implies that it is selling service, when actually it is guaranteeing payment for certain services which the physician and hospital must provide. Misunderstanding and dissatisfaction occur when the cost of services provided by the physician and hospital exceed the insurance company's indemnity, particularly when the policy holder has been led to expect full payment.

Physician's offices are often inadequately equipped for emergency care, and the physician finds it difficult to treat emergency patients for other reasons. The injured patient, with his

bleeding wound or grease-soaked clothing may cause a state of chaos in the office. Any physician would be willing to tolerate this in time of necessity, but when there is a hospital emergency department nearby, he believes that it is better prepared than he to render first aid and it is simpler for him to see his patient there for treatment.

Many problems have developed for the hospital with the increased volume of emergency visits. Physical expansion of this facility has been a complex one, particularly in hospitals where space is limited. The cost of remodeling or new construction suitable for the modern emergency ward is great as is the cost of equipment, upkeep and supplies.

Payment received for services rendered is poor in spite of meticulous attention to collection. This is another reason why emergency departments operate at a loss.

Staffing the department is often difficult because there must be well trained attendants and full time coverage. It is also a public relations problem for it is here that dramatic episodes occur about which the press may formulate headlines.

Since the emergency department is the avenue of admission to the hospital for approximately ten per cent of the patients treated in the department, it disrupts the elective or reservation system of admissions. This is another factor which has caused complication and dissatisfaction among the general public.

Spencer [10] points out in a recent article that the added patient load in the emergency ward may be the result of a difference of opinion between doctor and patient as to what constitutes an emergency. Regardless of the basic cause, criticisms continue to be leveled at the emergency department by unsatisfied patients. Are these complaints just or have we educated the public to expect a service beyond what can be reasonably provided?

Persons in one area were interrogated as to why they criticized their emergency department. The most frequent complaint was the length of time they had to wait. It was found that this is a variable period of time which can range from five minutes to three or more hours, depending on the anxiety and interpretation of the individual involved. One patient left an emergency department untreated and angered because he was told there would be a wait of over five minutes when he knew that another patient occupied the room and equipment he would require.

We must not forget that the patient's criticism can be legitimate if he has a problem which requires emergency treatment and has to wait for his turn while less urgent care is given to others. Most departments place the acutely ill or injured on a priority basis so that they are seen as quickly as possible. An effort is made to see other patients in their turn. Human nature being what it is, there is no method which will satisfy everyone since each person who waits feels sure that his problem is greater than any of the others. Often the most unreasonable demands come from persons who have had their illness or injury for days.

Another complaint was the routine of being asked questions before treatment. Investigation of this criticism revealed that the dissatisfaction often came from the necessary medical history taking and not the administrative questions of the admitting officer. One person objected when history was taken from his father who was vomiting blood. The son felt that immediate care was essential. Actually, this patient was to benefit in his eventual treatment by obtaining an accurate history since the source of hemorrhage was unknown.

Emergency room data is rarely obtained from patients with acute illnesses until treatment is under way or concluded. A member of the family is often used as the informer in order to relieve the patient. Many who complain of being asked questions are the same patients who later want a report sent to their insurance adjustor or lawyer. They would be the first to criticize if these records were not available and accurate. A sample record is shown in Figure 1.

Another complaint concerned medical personnel in the emergency room who actually administer treatment. Some patients felt that an intern or resident was not adequate to treat them. An astute house officer will avoid treating such people except in a dire emergency. Actually, there is no reason for the citizen to be critical of the hospital in this matter since he is completely justified in calling his own physician who can recommend or give treatment.

There will be occasions when a house officer must act immediately and take responsibility in treating a major emergency. In such situations the physician in charge should be notified. The house officer should not undertake major treatment when the attending physician is

NAME OF HOSPITAL, CITY, STATE
EMERGENCY DEPARTMENT RECORD

DATE | TIME A.M. P.M.
BROUGHT IN BY | INVESTIGATION NO.
PATIENT'S LAST NAME (PLEASE PRINT) | FIRST NAME | ADDRESS | ZONE | TELEPHONE NO.
NEAREST RELATIVE LAST NAME (PLEASE PRINT) | FIRST NAME | ADDRESS | ZONE | TELEPHONE NO.
DATE OF BIRTH | SEX M F | RACE W N O | MARITAL STATUS S M W D SEP | RELIGION C P J O | SERVICE | FAMILY PHYSICIAN | TELEPHONE | ATTENDING PHYSICIAN | TELEPHONE
EMPLOYER'S NAME | ADDRESS | SOCIAL SECURITY NO. | CLOCK NO.
SOURCE OF COLLECTION | C.H.S.A. POLICY NO. | NAME OF C.H.S.A. POLICY HOLDER | IND. | PVT. PAY | WELFARE AGENCY | PERS. | HEALTH SV. | OTHER INS.
NATURE OF ACCIDENT
DATE | TIME A.M. P.M. | WHERE OCCURRED: | MEDICATIONS | SIGNATURE OF SEC'Y. | INTERNE
WHO REFERRED PATIENT TO EMERGENCY WARD? | DID PATIENT WISH FAMILY PHYSICIAN NOTIFIED? YES NO
WAS THE FAMILY PHYSICIAN NOTIFIED? YES NO | DID THE FAMILY PHYSICIAN REFER THE PATIENT TO ANOTHER PHYSICIAN? YES NO
WAS THIS ATTENDING PHYSICIAN NOTIFIED? YES NO | TIME FAMILY PHYSICIAN WAS CONTACTED A.M. P.M.
TIME ATTENDING PHYSICIAN WAS CONTACTED A.M. P.M. | SIGNATURE OF EMERGENCY WARD PHYSICIAN.
COMPLAINT AND HISTORY
PHYSICAL EXAMINATION

FURTHER HISTORY & PHYSICAL EXAMINATION MAY BE WRITTEN ON BACK.

DIAGNOSIS
MEDICATION – TREATMENT | A.T.S. | TOXOID
X-RAY ORDERED OF: | X-RAY FINDINGS | ANESTHESIA LOC. GEN | SIGNATURE OF ANESTHETIST (IF GENERAL)
REFERRAL OF PATIENT | PRIVATE DOCTOR | ADMITTED | HOME | RETURN TO OUT-PATIENT CLINIC | SIGNATURE OF NURSE
DISPOSITION OF CLOTHING AND/OR VALUABLES | SIGNATURE OF PHYSICIAN RENDERING EMERGENCY CARE

RELEASE
I _____ wish to have _____ released from the care of (Name of Hospital), I acknowledge that this request is against the advice of the Doctor in charge of (The, My) case and agree that the Doctor and the Hospital shall not be responsible for the consequences of this action.
SIGNED:
WITNESS:

SURGERY PERMIT
I hereby consent to the administration of such Anesthetics and the performance of such surgery as deemed necessary or advisable while the patient is in (Name of Hospital)
NAME | RELATIONSHIP
ADDRESS | TELEPHONE NO.
WITNESS:

FIG. 1. A sample record for use in emergency departments.

available and if the patient does not require immediate care.

Ideally, it would be best to have a senior, experienced staff physician on duty at all times. Since this is impractical, the house officers on call can evaluate the situation and call the patient's personal physician for advice and treatment. It is then hoped that he will come to attend the patient or supervise treatment. Difficulties have arisen because the attending physician failed to see his emergency patient and delegated total responsibility to the house officers. If a poor result ensues under these circumstances, the responsibility should rest squarely upon the physician in charge of the case. On the other hand, a well trained intern or resident can competently do many of the procedures required in routine emergency care and then refer these cases to their physician for follow up. When this is done the private physician must be informed immediately as to the procedure performed, and there should be a definite system to check whether or not the patient followed through with the referral. One suggested method could be a definite check off system on the emergency record as soon as the physician,

who will handle the particular case, has been contacted. (Fig. 1.)

A particular criticism has been the assignment to the emergency department of physicians who have recently come from foreign countries and who are unable to communicate adequately. Consequently there may be misunderstanding and poor or inadequate treatment.

Is the emergency ward becoming a glorified office, or as one hospital superintendent put it, a diagnostic clinic open twenty-four hours a day which is replacing the former function of the neighborhood physician? Although practices vary depending upon its urban or rural location, we would say "yes," in many instances. In some areas patients have come to think of the emergency ward before they do their physician, or they may not think of him at all. If this attitude continues it will do much harm to physicians generally and to the doctor-patient relationship which has long been the backbone of American medicine.

People also complained that emergency wards were "cold" and that the medical personnel who treated them did not seem to care about them. This criticism stems from the fact that some patients expect to be treated as they would be in a private office. Ordinarily, when a patient visits the office of his family doctor, the physician does everything he can to satisfy him so that he feels comfortable and important. When he goes to the emergency room, he is evaluated, treated in his turn in a businesslike manner and discharged. The personal touch may be lost and the patient experiences a regimented form of medicine to which he is not accustomed. Perhaps a greater effort should be made to treat more than the physical need when time and circumstance permit.

It would appear, therefore, that we must educate the public as to the proper relationship between patient, emergency department, and physician.

We agree with others who have studied this problem that hospitals must expand, equip and staff their emergency wards to meet the demands of the community they serve. They must educate the citizens of the community to use the department intelligently. Part of this education would include a working definition of what an emergency is. We like to think of an emergency as any acute illness or exacerbation of a chronic illness which is dramatic in its onset and severe in symptoms, or any trauma to the body which is severe enough to require immediate surgical attention.

Night clinics at the hospital have been advised for the handling of indigent patients who cannot attend daytime clinics. Local medical groups should provide emergency call services where private physicians in the community may share this responsibility. This plan has worked successfully in many areas. The public must be educated to call their own physician when an emergency exists and the emergency call service when he is not available.

It must be clear to the people in the community that they will receive no treatment if their illness is not an emergency and that this decision is up to the discretion of the physician in charge of emergency admitting.

Perhaps emergency wards will have to consider rotating their senior staff members through this department so that each one takes a period of duty as physician in charge.

Third party payers, such as insurance companies and hospitalization groups, should exercise more self control in their sales and in their coverage of emergency cases so that the patient is not encouraged to abuse the emergency room with excessive demands. Physicians must also be conservative in their orders on patients who are covered by one or another type of insurance or by a company.

Persons involved in patient care in the emergency department must be able to speak the language of the majority of the patients of the community. Where there are foreign groups, it would be advisable to have some attendants speaking those languages to act as interpreters.

Particular emphasis must be placed on the public relations factor of this department and a full time expert would be of advantage to the hospital as a whole. The personnel involved should conduct themselves so there is no question of their interest, kindness, and efficiency in the eyes of the public. It is essential that they maintain rapport with the police, fire department and the press. Good public relations between physicians of the community and emergency room personnel are most important. Careful attention should be paid to medical ethics in showing respect to the patient's family physician and leaving the matter of referral up to him. This should be practiced whether or not the outside physician is a member of the hospital staff or the particular emergency ward involved.

The physician must be educated to use the emergency room for purposes for which it was originally intended and not as a second office. He may have to do some additional laboratory work in his office and care for minor injuries. Private laboratories are available for the physician who does not wish to do laboratory work himself although this may be added expense to the patient. To alleviate this problem insurance companies must be encouraged to extend their coverage to include x-ray, laboratory and minor surgical procedures done outside the hospital.

The position of the house officer in relation to the emergency department must be clearly defined, especially regarding his limitations. No physician should place unnecessary responsibility on these persons in training. The results of this defection of responsibility has caused some hospitals to appoint full time physicians in charge of their emergency wards.

SUMMARY

In recent years there has been a remarkable increase in the use and services provided by emergency wards. This is the result of a genuine desire of physicians, hospital trustees and administrators to serve the lay public. It is also due to education of the lay public in the services obtainable in the emergency ward, revision of the scope of services provided in the private physician's office, and a desire of third party payers to obtain prompt and standardized treatment of the injured.

The administrative and professional responsibilities and pitfalls as well as their legal implications are discussed. Recommendations are made for improvement of service with protection of legal rights.

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Experimental Appraisal of Agents Employed as Angiocardiographic and Aortographic Contrast Media

III. CARDIOVASCULAR RESPONSE TO INTRA-AORTIC DISSEMINATION

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It was apparent that study of the specific cardiovascular responses to aortic injection of the currently available aortographic (or angiocardiographic) contrast agents was merited as a part of an attempt to achieve an over-all appreciation of the effects of systemic dissemination of angiographic contrast media. Previous reports have indicated that there is a significant danger of injury to specific organs (spinal cord and kidney) associated with abdominal aortic injection of these contrast agents [*5,6*].

METHOD

Sodium iodide (*54.6* per cent w/v), Urokon (sodium acetrizoate *70* per cent w/v), Neo-Iopax® (sodium iodomethamate *75* per cent w/v), Miokon® (2:1 mixture of methylglucamine and sodium diprotrizoate *90* per cent w/v), Diodrast® (iodopyracet *70* per cent w/v), Hypaque® (2:1 mixture of methylglucamine and sodium diatrizoate *90* per cent w/v), and Thorotrast® (thorium dioxide *25* per cent v/v) were subjected to the evaluative procedures described herein. The substances enumerated above represent the more readily available contrast media in the highest concentrations currently marketed, with the exception of sodium iodide (*54.6* per cent). The concentration of sodium iodide chosen for use in this study is such that its iodine content is comparable to the iodine content of those organic iodide contrast media tested.

Unselected adult mongrel dogs were used as the test animals for assessing the cardiovascular responses to aortic instillation of the angiographic contrast solutions. Anesthetization was accomplished by the intravenous injection of veterinary nembutal (30 mg./kg.). The animals were placed in the supine position and the abdominal aorta was exposed by laparotomy using sterile precautions.

The pre-injection preparation included securing standard limb leads for routine bipolar electrocardiographic tracings and insertion of a No. 18 venipuncture needle into the femoral artery to facilitate continuous blood pressure recording during and following aortic injection of the contrast agents.

The aortic instillation of the test contrast materials was performed as follows: The tip of a No. 18 needle was slanted cephalad after puncture of the anterior wall of the aorta 1 cm. below the origin of the left renal artery, and *15* cc. of contrast medium were manually injected over a period of five seconds.

Blood pressure was continuously monitored from a femoral artery by means of a Statham strain gauge (Model 7873) attached to a Sanborn multiple channel recorder (Model 67-1200). The electrocardiographic activity was registered on the recorder simultaneously with the blood pressure values; one of the standard limb leads (I, II, or III) was used. Each animal served as its own control and the pre-injection data was compared with information

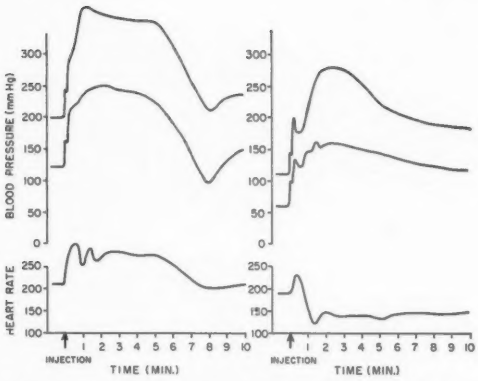

FIG. 1. Blood pressure and pulse behavior following intra-aortic injection of sodium iodide. *Left*, No. 424; *right*, No. 423.

which was routinely collected during the injection phase and over a period of five to ten minutes following injection.

RESULTS

Sodium Iodide. The graphic presentation of the pulse and blood pressure changes observed following the intra-aortic injection of sodium iodide is illustrated in Figure 1. The basic changes consist of an immediate tachycardia and marked elevation of blood pressure (within the first one to two minutes of the post-injection period). Following this initial phase the heart rate (except for bursts of arrhythmias) slowly returns to pre-injection levels while the blood presssure gradually falls and reaches a plateau at a value slightly above the control readings.

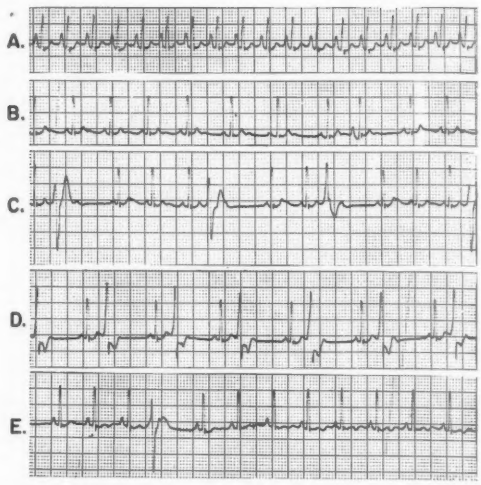

FIG. 2. Electrocardiogram following intra-aortic injection of sodium iodide. A, control tracing; B, occasional premature auricular contraction 1 min. 30 sec. following injection; C, multifocal premature ventricular contractions 1 min. 40 sec. following injection; D, ventricular bigeminal rhythm caused by ventricular premature systoles from one focus 2 min. 15 sec. following injection; and E, reversion to sinus rhythm 5 min. following injection. Note biphasic T wave. No. 423, sodium iodide, lead 1.

Electrocardiographic changes are shown in Figures 2 and 3 and consist principally of runs of premature auricular contractions, ectopic ventricular contractions, bigeminal rhythm, and bursts of premature ventricular contractions originating from multiple foci.

Urokon. Subsequent to injection an imme-

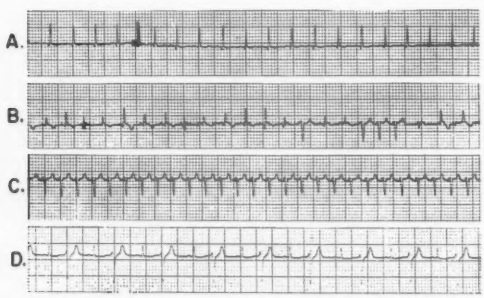

FIG. 3. Electrocardiographic change following intra-aortic injection of sodium iodide. A, control tracing; B, supraventricular tachycardia with aberrant atrioventricular conduction progressing to ventricular tachycardia 1 min. 10 sec. following injection; C, ventricular tachycardia 1 min. 20 sec. following injection; D, bigeminal rhythm caused by ventricular premature systoles from one focus 8 min. following injection. No. 424, sodium iodide, lead 1.

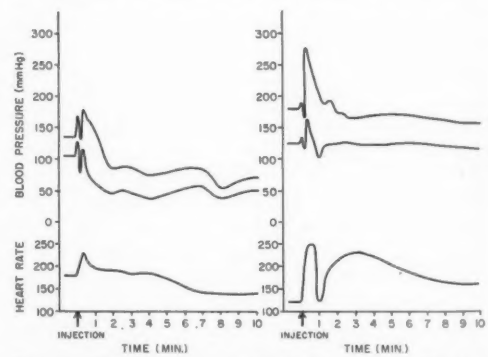

FIG. 4. Blood pressure and pulse behavior following intra-aortic injection of Urokon. *Left*, No. 417; *right*, No. 418.

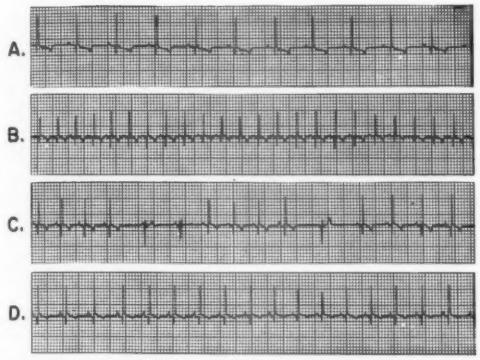

FIG. 5. Electrocardiographic changes following intra-aortic injection of Urokon. A, control tracing; B, sinus tachycardia 40 sec. following injection; C, sinus pauses with ventricular escape beats (either alone or as a fusion beat with the returning sinus focus) 50 sec. following injection; and D, return to sinus rhythm 1 min. 20 sec. following injection. No. 418, Urokon, lead I.

diate rise in blood pressure (peak pressures in twenty to twenty-five seconds) and tachycardia were observed. In contradistinction to the effects of sodium iodide, the lysis of the blood pressure occurred earlier and was carried to subnormal levels when compared with control values. (Fig. 4.)

Sinus pause with ventricular escape seen in one animal was the only arrhythmia documented by the electrocardiograms. Depression of the ST segment was manifested early in the post-injection period in each animal and was found to be relatively persistent throughout the tracings. (Fig. 5.)

Neo-Iopax. Post-injection hypertension (peak levels one minute post-injection) to levels of more than two times control values were recorded. The duration of the hypertension was more sustained than that exhibited by the animals given Urokon, and a qualitative difference was the failure of the blood pressure to fall below baseline measurements. (Fig. 6.)

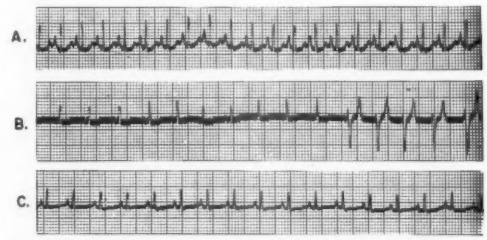

FIG. 7. Electrocardiographic changes following intra-aortic injection of Neo-Iopax. A, control tracing; B, nodal rhythm associated with aberrant ventricular conduction 1 min. 20 sec. following injection; and C, reversion to normal sinus rhythm 10 min. following injection. Note T wave changes. No. 696, Neo-Iopax, lead III.

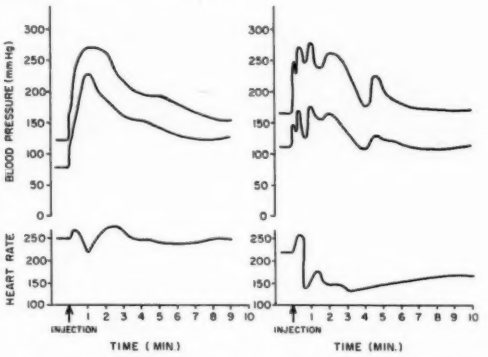

FIG. 6. Blood pressure and pulse behavior following intra-aortic injection of Neo-Iopax. *Left*, No. 695; *right*, No. 696.

No significant changes of heart rate or significant alterations of electrocardiographic patterns were noted in one of the two test animals. The electrocardiographic tracing of the second test animal disclosed a shift of the pacemaker to the atrioventricular node with the appearance of an intraventricular conduction block. (Fig. 7.) Late inversion of the T wave was also observed. Variations of both blood pressure and cardiac rate reflected these rhythm changes. (Fig. 6.)

Miokon. Blood pressure responses to the injections of this material were of the Neo-Iopax pattern. (Fig. 8.) There were no arrhythmias or specific changes in rate, and the only

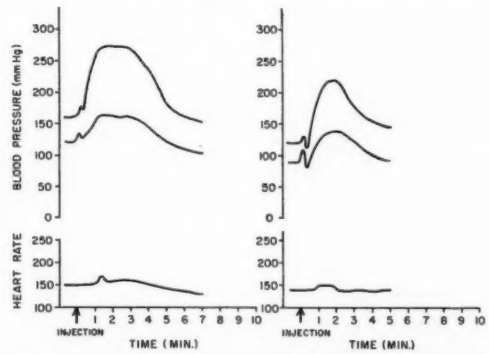

FIG. 8. Blood pressure and pulse behavior following intra-aortic injection of Miokon. *Left*, No. 402; *right*, No. 403.

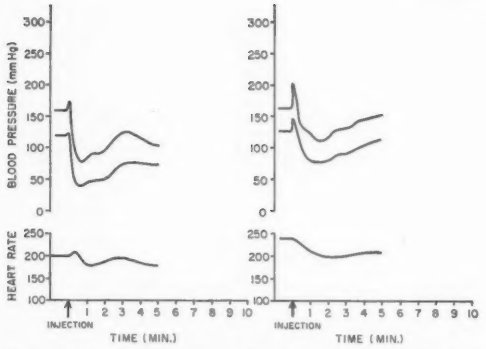

FIG. 9. Blood pressure and pulse behavior following intra-aortic injection of Diodrast. *Left*, No. 516; *right*, No. 517.

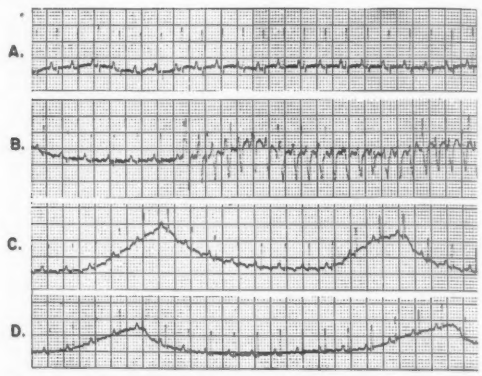

FIG. 10. Electrocardiographic changes following intra-aortic injection of Diodrast. A, control tracing. B, parasystolic ventricular tachycardia 1 min. 10 sec. following injection. This parasystolic focus of discharge gives rise to a ventricular tachycardia at a rate of 350 beats per minute. Throughout this arrhythmia the normal complexes continue completely unaltered save for a simple cancellation of potentials. There are no fusion beats and no significant changes in the rate of either focus. The concomitant pulse tracing shows that each segment of musculature produces a mechanical systole and that when they occurred simultaneously there was a summation of the effect. C, reversion to sinus rhythm 2 min. following injection; note inversion of T wave. D, normal sinus rhythm with regression of T wave changes 5 min. following injection. No. 517, Diodrast, lead III.

electrocardiographic abnormality was a transient flattening of the T segment.

Diodrast. Blood pressure tracings in these animals demonstrated a small immediate rise (during the period of actual injection) with an immediate secondary fall below baseline values. A slow return toward normal levels followed. (Fig. 9.)

In one animal a short burst of parasystolic ventricular tachycardia appeared. (Fig. 10.) Other electrocardiographic alterations were confined to inversion of the T wave and depression of the S-T segment. There was regression of these changes at the end of the observation period.

Hypaque. No important changes in either blood pressure or pulse were discovered in one animal. An early transient rise of both blood pressure and pulse characterized the response of the second animal. (Fig. 11.)

Electrocardiographic recordings demonstrated transient mild S-T segment depression in one animal and rare premature ventricular contractions in the other animal while only transient T wave depression or inversion was noted in both animals.

Thorotrast. Early and questionably significant rise of blood pressure occurred in one animal while no changes of either blood pressure or

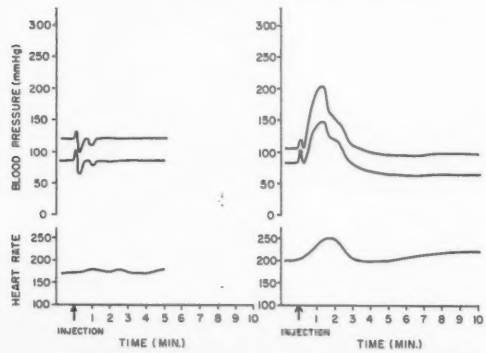

FIG. 11. Blood pressure and pulse behavior following intra-aortic injection of Hypaque. *Left*, No. 477; *right*, No. 478.

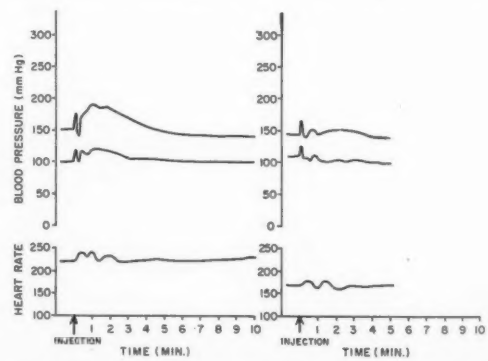

FIG. 12. Blood pressure and pulse behavior following intra-aortic injection of Thorotrast. *Left*, No. 719; *right*, No. 720.

TABLE 1

CARDIOVASCULAR RESPONSE TO INTRA-AORTIC INJECTION OF THE CONTRAST AGENTS

Substance Administered	Animal	Post-injection Hypertension	Post-injection Hypotension	Ventricular Arrhythmia	S-T Segment Depression	Non-specific T Wave Changes
Sodium-Iodide	423	++++	None	+++	None	+
	424	++++	None	++++	None†	+
Urokon	417	+	++++	None	+	+*
	418	++	++	+	+	+*
Neo-Iopax	695	++++	None	None	+	+*
	696	++	None	++	None	+
Miokon	402	++	None	None	None	+
	403	++	None	None	None	+
Diodrast	516	None	++++	None	+	+*
	517	None	++++	+++	None	+
Hypaque	477	None	None	+	None	+
	478	++	+	None	+	+*
Thorotrast	719	+	None	None	None	None
	720	None	None	None	None	None

* T wave changes associated with S-T segment depression were presumed to be ischemic in origin.
† There was S-T segment elevation associated with an inverted T wave.

pulse occurred in the second animal. (Fig. 12.) Electrocardiographic tracings demonstrated no significant changes during the injection and post-injection periods.

COMMENTS

An inspection of the blood pressure tracings reveals an immediate (usually within three to six seconds) small peak (range of 10 to 85 mm. Hg with mean of 32 mm. Hg) in all animals but one (No. 695). In this animal there was a transient flattening of the curve at the height of the early elevation before the secondary rise of blood pressure began. It is believed that these early or primary peaks can be related to the mechanical effects of rapid injections of relatively large amounts of fluid into a closed system with a small capacity as they occur in such time relation to make this seem the most plausible explanation [*1,3,11*].

The deviations of blood pressure which succeeded these initial peaks are considered to be the true representations of the pharmacologic response of the cardiovascular system to the injected contrast media. The rises in pressure consistently observed following sodium iodide, Neo-Iopax, Miokon and, Urokon injection most likely reflect contraction of the peripheral arterial bed. The less constant and smaller variations in blood pressure caused by Hypaque and Thorotrast probably have their genesis on the same basis. However, it should be noted that vasodilatory responses in general have been observed to follow the more central instillations of contrast agents (angiocardiography and thoracic aortography), and the abdominal aortic or peripheral arterial injections of small volumes of or dilute solutions of angiographic contrast media [*1–3,7,9,11*]. This difference in response may be related to the greater concentration and greater volume of the contrast bolus that reaches the peripheral vascular bed following abdominal aortic injection as performed in this study, for arterial spasm has been shown to result from rapid direct arterial injection of contrast agents (femoral arteriography) [*4,10*].

The antithesis of the above responses is exemplified by Diodrast. The hypotension which follows the administration of this substance seems best explained by a reactive vasodilatation. However, the electrocardiographic changes (S-T and T segment changes) noted in this instance may offer evidence for another conclusion as they indicate impairment of myocardial function, but it is our impression that anoxia (as demonstrated by the above electrocardiographic changes) is secondary to the hypotension rather than the cause of it.

The post-injection hypertensive peaks were created within one to two minutes after injection with the exception of that following instillation of Urokon which appeared within approximately twenty seconds. The more gradual lysis of the blood pressure and its return to baseline values possibly indicate recovery of normal vascular tone with the dissipation of

the stimulus. A similar recovery curve followed in those animals exhibiting initial hypotension. The genesis of the post-injection changes of vascular tone is thought to be based on direct stimulation of nerve endings and/or smooth muscle fibers of the arterial bed [*4,10*]. However, injury to the spinal cord with massive sympathetic stimulation is a possible mechanism of this reaction [*6*].

An analysis of the electrocardiograms permits classification of the changes into two major categories. The first of these reflect a state of myocardial hyperirritability manifested by the appearance of ectopic foci of discharge. This is believed to be the result of direct myocardial irritation following contact with the injected contrast material, as these same changes have been observed to appear immediately upon injection of contrast media directly into the coronary arteries [*3,12*]. In the present study these irritative phenomena did not appear immediately upon injection but appeared a half to one and a half minutes following aortic instillation. This delay is thought to be due to the more peripheral injection of the contrast agent necessitating its recirculation prior to contact with the myocardium.

The second category of electrocardiographic abnormalities relates primarily to changes in repolarization and indicates myocardial ischemia. These changes are exemplified by S-T segment depression and/or flattening, inversion, and biphasic movements of the T wave. In most instances hypotensive states can be correlated with the S-T segment depression and are thought to be the basis for its presence. (Table 1.) The other (non-specific) T wave alterations were noted more frequently and may be related to alterations in the cardiac rate, rhythm, or blood pressure produced by the contrast agents.

That these cardiovascular reactions to injected contrast materials have clinical significance is indicated by the results of McAfee's survey of complications resulting from 13,207 abdominal aortograms [*8*]. In this series toxic cardiovascular responses were among the three most frequent causes of death.

It is possible to quantitate the magnitude and severity of these cardiovascular responses and to list in descending order of toxicity the materials studied as follows: (1) sodium iodide, (2) Urokon, (3) Diodrast, (4) Neo-Iopax, (5) Hypaque, (6) Miokon, and (7) Thorotrast. It can be appreciated from the data that minimal differences exist between the cardiovascular responses to certain of the contrast media. This fact and the utilization of small groups of animals render a strict interpretation of the above listing unwarrented.

The practical application of the information derived from these studies would find expression in the selection of a contrast agent for use in those instances where angiocardiography or aortography is contemplated in patients exhibiting tendencies which might enhance the cardiovascular response to the agent employed.

Acknowledgment: We are grateful for the help of Stephen Schillig, M.D. of the Department of Medicine, Vanderbilt University School of Medicine, in the analysis of the electrocardiographic tracings. Winthrop Laboratories, Mallinckrodt Chemical Works, and Schering Corporation generously contributed supplies of their respective products for utilization in this study.

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Modified Neck Dissection for Thyroid Carcinoma

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ALTHOUGH the majority of surgeons individualize lateral neck surgery in patients with operable carcinoma of the thyroid, policies vary from the performance of routine neck dissections to the excision of only the nodes that clinically appear to contain metastases. Large numbers of patients have not been followed long enough to establish with finality the indications for and the necessary extent of cervical node surgery in this condition, but the evidence at hand does provide direction in formulating working policies. It has become our practice to perform some type of node dissection in a majority of the patients with carcinoma of the thyroid. The classical radical neck dissection has been used for those patients with obvious metastatic spread to multiple cervical nodes.

MATERIAL

A total of 143 patients have been operated upon at the Henry Ford Hospital from 1924 through 1959 with the hope for cure of carcinoma of the thyroid. These patients comprise the basis for this discussion. One operative death occurred in 1928. In addition twenty-two patients were seen with advanced thyroid carcinoma for whom only diagnostic or palliative procedures were possible. These are not included in this study.

The patients have not been classified here on the basis of the histologic variety of thyroid malignancy for the surgeon usually must determine the scope of surgery on the basis of the clinical evidence of the extent of the disease. This decision must frequently be made at the operating table when an exact histologic classification may not be possible by frozen section study of various areas of the malignancy. Mixtures of several varieties of microscopic types of carcinoma are often present. There is no sharp delineation as to which microscopic types of thyroid carcinoma spread to lymph nodes and which do not [1]. In our experience many follicular carcinomas do spread to cervical lymph nodes. However, the microscopic classification is of value in determining prognosis.

The 143 patients have been divided into two groups depending on the presence or absence of palpable cervical lymphadenopathy preoperatively. In thirty-two patients, lymph nodes were palpable preoperatively whereas they were not in 111 patients. The number of patients for whom cervical lymph nodes were removed in varying degrees of extensiveness along with follow-up periods for each group is shown in Table 1.

TABLE 1
DEFINITIVE SURGERY FOR CARCINOMA OF THE THYROID (1924–1959)*

Status of Lymph Nodes	No. of Patients	Follow-up		Total
		3 Yrs.	5 Yrs.	
Palpable cervical lymphadenopathy				32
No cervical nodes removed...	0	0	0	
Excision group of neck nodes.	15	12	11	
Modified neck dissection.....	5	3	1	
Radical neck dissection.....	12	9	6	
Total.....	32	24	18	
No palpable cervical lymphadenopathy				111
No cervical nodes removed...	67	49	29	
Excision group of neck nodes.	9	9	3	
Modified neck dissection.....	20	6	3	
Radical neck dissection.....	15	9	5	
Total.....	111	73	40	
Total number of patients..				143

* The total number of patients receiving varying types of neck dissections and the total number of patients for whom these dissections were performed over three and five years ago are indicated.

TABLE II
FREQUENCY OF METASTASES TO CERVICAL NODES*

Status of Nodes	Total Examined	Benign	Malignant
Palpable	32	2	30 (94%)
Not palpable	44	28	16† (35%)
Totals	76	30	46 (61%)

* Patients in whom neck dissection was performed are included.

† In five of sixteen patients, positive nodes were removed when cervical lymphadenopathy appeared six months to ten years after the original surgery.

The frequency of occurrence of metastases to lymph nodes in those patients whose nodes were examined is shown in Table II. It is seen that metastases are actually present in nearly all of the patients (94 per cent) when cervical nodes are palpable. In about one-third of patients in whom palpable cervical lymphadenopathy was not present, metastases to the nodes were actually present. There were sixteen such patients with metastases to cervical nodes which were not palpable prior to the surgical removal of the primary malignancy of the thyroid. However, in five of these sixteen patients the cervical nodes were not removed until the nodes became clinically palpable six months to ten years after the original thyroid surgery.

TABLE IV
THREE-YEAR FOLLOW-UP STUDY*
(Palpable Cervical Lymphadenopathy)

Status of Patients	Excision of Group of Nodes	Modified Neck Dissection	Radical Neck Dissection	Total
Living (free of disease)	3	3	5	11
Cervical node recurrence	7†	0	0	7
Mediastinal recurrence	1	0	1	2
Distant metastases	2	0	2	4
Died (carcinoma of thyroid)	1	0	2	3
Died (unrelated cause)	1	0	1	2
Total	12	3	9	24

* Subsequent course during three year follow-up of patients with palpable cervical lymphadenopathy at the time of original thyroid surgery is shown.

† Radical neck surgery subsequently performed on three patients.

The subsequent clinical course for patients without palpable cervical lymphadenopathy followed at least three years is outlined in Table III. It is seen that six of the fifty-three patients for whom no cervical node surgery was performed at the time of the original thyroid surgery were found to have metastases to these nodes later. This was confirmed by microscopic examination of excised nodes in five patients. In the sixth patient metastases to cervical nodes were obvious clinically, but the nodes were not removed. Two of the patients died from carcinoma of the thyroid. The number of patients in whom cervical node dissections

TABLE III
THREE-YEAR FOLLOW-UP STUDY*
(No Palpable Cervical Lymphadenopathy)

Status of Patients	Neck Dissection	Excision of Group of Nodes	Modified Neck Dissection	Radical Neck Dissection	Total
Living (free of disease)	42	6 (2†)	6 (2†)	7 (1†)	61
Cervical node recurrence	6	0	0	0	6
Mediastinal recurrence	5 (5†)	0	0	0	5 (5†)
Distant metastases	5 (3†)	0	0	0	5 (3†)
Died (carcinoma of thyroid)	2 (2†)	0	0	0	2 (2†)
Died (unrelated cause)	3	0	0	0	3
Total	53	6	6	7	72

* Subsequent course during three year follow-up period of patients without palpable cervical lymphadenopathy at time of original thyroid surgery is shown. One operative death is not included. Five patients for whom cervical nodes were not removed at the time of the original surgery later underwent cervical node dissection for metastases to these nodes.

† Number with cervical nodes positive for metastases is indicated.

were performed is small, but none of these patients have had subsequent difficulty with carcinoma of the thyroid. The one operative death occurring in 1928 is not included in the data shown in this table; cervical surgery was not performed on this patient.

The presence of palpable cervical lymphadenopathy in a patient with carcinoma of the thyroid indicates not only the presence of metatases to these nodes but also, in many of these patients, metastases to additional cervical nodes which were not palpable. Thus, if only the palpable nodes are removed, many of the patients subsequently require removal of additional nodes that become palpable (seven of twelve patients, Table IV). However, these patients frequently live in comfort for long periods of time. Only three patients of twenty-four followed at least three years have died of the disease.

TABLE V

A PLAN FOR NECK DISSECTION IN THE SURGICAL TREATMENT OF THYROID CARCINOMA

I. Remove nodes adjacent to thyroid and in superior mediastinum through neck incision
   A. In all patients operated for cure
II. Radical neck dissection
   A. Palpable cervical metastases present, primary lesion and cervical metastases operable
III. Modified neck dissection
   A. Positive nodes adjacent to thyroid, no palpable cervical adenopathy
   B. Multicentric carcinoma or intrathyroid metastases in one lobe, cervical nodes not palpable
   C. Definite thyroid carcinoma on frozen section, few small cervical nodes palpable or nodes not palpable
   D. Large or multicentric carcinoma on fixed sections, no cervical adenopathy, do neck dissection as second operation
IV. No neck dissection
   A. Centrally located isthmus malignancy, no cervical adenopathy, thyroid otherwise free of carcinoma
   B. Minute area thyroid malignancy on fixed sections, no cervical adenopathy
   C. Malignant adenoma
   D. Pathologic diagnosis of malignancy questionable
   E. Inoperable for cure locally or because of distant metastases

COMMENTS

There are many facets to the question as to whether or not a modified neck dissection should have a place in the treatment of carcinoma of the thyroid. The question cannot be answered with finality now because of the lack of statistically valid data based on large numbers of patients studied over a long period of time. In general, a comprehensive consideration of available evidence leads us to believe that a modified neck dissection as we define it is a valuable component in the individualized treatment of certain patients with carcinoma of the thyroid. Considerations leading to this conclusion are evident, in answering the following questions.

Should a neck dissection ever be performed in the treatment of carcinoma of the thyroid? This question rightfully may be asked in view of the fact that the natural history of the disease is such that its presence is still compatible with long life in many patients. The mortality rate for the papillary and follicular varieties is especially low. Since death from the disease is usually related to distant metastases, local effects of the primary lesion, or mediastinal metastases on the trachea and esophagus, the metastases to lymph nodes in lateral areas of the neck appear to be of secondary importance. In view of the low mortality from the disease early in its course, many physicians have been reluctant to perform disfiguring operations in order to remove lateral cervical nodes.

The evidence which favors the utilization of a neck dissection in the treatment of carcinoma of the thyroid includes the following:

1. One of the basic principles in the treatment of carcinoma is the *en bloc* removal of the primary lesion along with the regional routes of lymph node spread insofar as possible and as early as posssible. This has proved to be valid in the treatment of other forms of carcinoma. Although carcinoma of the thyroid does have a different natural history than many neoplasms, it is reasonable to expect this approach to surgical therapy to be beneficial also in the long term management of this malignancy.

2. Although short term studies indicate that few patients with carcinoma of the thyroid die of the disease, studies over longer periods of time demonstrate that these patients do die of the disease in increasing numbers as the follow-up period lengthens [2,3]. Furthermore, carcinoma of the thyroid does metastasize widely in some individuals and can result in death in a short period of time. How carcinoma of the thyroid will progress in a patient cannot always be predicted. Therefore, it appears reasonable to treat it as carcinoma is generally treated now,

that is, by complete eradication of the primary growth along with adjacent areas of possible extension as early as possible.

3. Our experience indicates that if palpable cervical lymphadenopathy is present, nearly all of the patients with carcinoma of the thyroid do have metastases to the nodes. Therefore, if the lesion is operable, removal of these nodes is indicated.

4. In our experience at least one-third of patients without palpable cervical lymphadenopathy do have metastases to the nodes if carcinoma of the thyroid is present. Thus, the advisability of performing a lateral neck dissection in this group of patients is not so definite. Yet is is suggested that better results may be expected if a neck dissection is performed. Valid statistical analyses of patients on the basis of cervical and distant metastases will be required to settle this issue. In considering neck dissections for this group of patients, one is probably comparing the advantage of a few percentage points of possible help against a fraction of a per cent of detrimental effects.

5. The mortality of neck dissection is nearly zero, and the morbidity in terms of postoperative duration of hospitalization and postoperative discomfort and disability is low.

Thus, we favor the application of neck dissection in the treatment of carcinoma of the thyroid in a high percentage of the patients.

If neck dissections are performed for carcinoma of the thyroid, can the procedure be performed with maximum effectiveness if applied only to those patients with clinical evidence of metastases to cervical nodes? Since much thyroid surgery currently is being performed to remove thyroid nodules which might be malignant, carcinoma of the thyroid is being diagnosed at earlier stages before the primary growth has produced palpable metastases to cervical nodes. Thus, this question is one which frequently deserves consideration now. Unfortunately, a decisive answer cannot be given on the basis of data accumulated to date. Cervical node metastases can undoubtedly be removed completely in certain patients, even though the procedure is performed a period of time after surgery to remove the primary lesion has been performed, at the time clinical evidence of cervical metastasis does appear. However, if time is permitted to lapse until node metastases become clinically apparent, it is conceivable that cervical metastases may be more extensive and more difficult to remove completely. In addition, if metastatic nodes adjacent to the thyroid and in the lateral cervical areas are removed early in the disease before they are evident clinically, it is conceivable that the occurrence of mediastinal and distant metastases can be reduced. A few patients without cervical lymphadenopathy at the time of removal of the primary thyroid lesion do die some years later from widespread metastases, including cervical and mediastinal node metastases, from the carcinoma [4].

We prefer to treat malignancy by radical surgery in early stages of the disease rather than in late stages. The morbidity and mortality from neck dissections do not contraindicate the application of this principle in the surgical treatment of carcinoma of the thyroid. Therefore, we prefer to proceed with neck dissections in most patients when the presence of carcinoma of the thyroid is established.

Is removal of isolated palpable cervical nodes or a group of nodes sufficient lateral neck surgery in the treatment of carcinoma of the thyroid? If only one or several nodes that are palpably enlarged are removed and are found to contain metastatic thyroid carcinoma, many of the patients require subsequent surgery for cervical metastases that become evident clinically (Tables III and IV). Thus, seven of twelve patients in the group which had palpable cervical lymphadenopathy preoperatively required further surgery for cervical node metastases if only one of several nodes containing metastases were removed at the time of the original surgery. This has led us to prefer a more complete removal of cervical lymph nodes.

Information available, however, does not decisively demonstrate that initial removal of only single or a group of palpably enlarged cervical nodes containing metastases will be less effective than more extensive neck dissections in prolonging life. Thus, Beahrs and Woolner [5] report that removal of groups of nodes containing metastatic papillary carcinoma of the thyroid has never resulted in lack of control of the malignancy due to inadequate procedures in the lateral areas of the neck. However, some of these patients have required subsequent procedures to remove additional metastatic malignancy in cervical nodes. Nevertheless, we prefer to treat malignancy of the thyroid by a procedure which minimizes recurrence, and our data indicates that a radical

neck dissection or the modified neck dissection that has been used will accomplish this goal best.

What is the modified neck dissection? The degree of extensiveness of even the standard or classical radical neck dissection will vary with individual surgeons and even with different patients. However, the failure to remove certain structures that are removed in the classical radical neck dissection has led to the use of the term, modified neck dissection. The operation may be modified in many ways and the mere removal of a group of nodes has been designated as a modified neck dissection by some.

We prefer to utilize a modified neck dissection which might be expected to be equally as effective as the classical radical neck dissection for most patients with carcinoma of the thyroid. This modified neck dissection should, in our opinion, include removal of all structures that are removed in a radical neck dissection except the sternocleidomastoid muscle and the region of the submaxillary gland. Thus, it includes removal of the internal jugular vein and associated lymph nodes and it includes a dissection of the posterior triangle of the neck.

What are the advantages and disadvantages of the modified and radical neck dissections? The modified neck dissection as we have defined it has only one clearly defined advantage for the patient: it is less deforming. This is especially advantageous in treating young girls, who seem to have been afflicted more often with carcinoma of the thyroid in recent years. Preservation of the sternocleidomastoid muscle and submaxillary gland avoids the unilateral depression and asymmetry of the neck which follows the classical or standard radical neck dissection. Yet the modified neck dissection as used in selected patients has been as effective as the radical neck dissection thus far in our experience. The submaxillary gland area has not been removed since this is an area to which thyroid carcinoma metastasizes infrequently. Only 1.5 per cent of patients without palpable cervical lymphadenopathy were found to have nodal metastases to this area in a group of patients with papillary carcinoma of the thyroid studied by Frazell and Foote [6]. If a dissection of the submaxillary gland area is omitted, the superior extension of the skin incision may also be limited.

The disadvantages of the modified neck dissection can be listed as the advantages of the classical radical neck dissection. Unless the sternocleidomastoid muscle is removed, it is difficult to remove the nodes high in the posterior triangle of the neck and under this muscle and the adjacent trapezius muscle. These lymph nodes may be involved, especially in patients with extensive metastases to the cervical lymph nodes. The removal of these nodes is facilitated by the division of the sternocleidomastoid muscle and reflection of the ends of the muscle which may be reapproximated when the procedure is completed

It may be argued that if a neck dissection is performed, all nonvital structures should be removed from that side of the neck. This is, of course, better accomplished by a radical neck dissection. The question to be answered is whether a modified neck dissection as we have defined it is definitely adequate in certain groups of patients to eradicate metastatic spread to cervical nodes. Thus far, the modified neck dissection has appeared to be satisfactory in the patients for whom we have used it. We have not used the modified procedure in patients who might be expected to have involvement of the sternocleidomastoid muscle or submaxillary gland area.

A Plan for Neck Dissections in the Surgical Treatment of Carcinoma of the Thyroid. The policy, in general, that we have utilized with respect to lateral neck surgery for carcinoma of the thyroid is as follows. It can be seen that the modified neck dissection is performed for the most part on patients without palpable cervical lymphadenopathy. In our experience approximately one of every three of this group of patients actually have metastases to cervical nodes. It has seemed undesirable to us to subject two-thirds of this group of patients to a more disfiguring operation when metastases are not even present in the lymph nodes. Metastatic spread to cervical nodes is in early stages even in the one-third of this group that do have cervical metastases. Even though the deforming features of radical neck surgery are not severe in some patients, asymmetry is obvious in most patients following this procedure. The classical radical neck dissection is performed for those patients with obvious extensive metastatic spread to cervical lymph nodes.

The most important component in the surgical approach to carcinoma of the thyroid remains, of course, the complete removal of the primary lesion. A total or near total thyroid-

ectomy is often indicated [7]. More extensive lateral dissections are not reasonable unless lymph nodes adjacent to the thyroid are removed. These nodes are found superior and inferior to the thyroid, along the tracheoesophageal groove and adjacent to the recurrent laryngeal nerve.

Thus far we have not adopted a policy of removing the lymph nodes adjacent to the thyroid first and proceeding with a neck dissection only if these more proximal nodes contain metastases. Frozen section recognition of metastases to the nodes is time consuming and often uncertain at the time thyroid surgery is performed and probably does not always indicate whether or not metastases are present in nodes farther removed from the thyroid itself.

Even the radical neck dissection does not always remove all lateral spread of cervical metastases. Involved nodes can be missed and spread can occur to nodes beyond the limits of the standard procedure. In a few patients, spread will have occurred also to the contralateral side of the neck.

Another important consideration concerns spread of carcinoma of the thyroid to mediastinal nodes. In this location serious and fatal complications can develop because of invasion of or mechanical compression of the trachea and esophagus. McClintock [8] has reported metastases to mediastinal lymph nodes in 76 per cent of a group of seventeen patients for whom a dissection of the anterior mediastinum was performed. We have observed clinical difficulty with mediastinal recurrence especially in patients who also have had recurrent evidence of cervical node metastases following removal of one or a group of metastatically involved cervical nodes. We routinely endeavor to remove all nodes from the anterior superior mediastinum through the neck incision. Thus far, the risk of meticulous mediastinal dissection following splitting of the manubrium and sternum has negated its routine use. Whether or not more extensive mediastinal dissections should be performed cannot be stated. Extensive mediastinal metastases have most often occurred in patients who also have widespread metastases throughout the body.

SUMMARY

The presence of palpable cervical lymphadenopathy in patients with carcinoma of the thyroid nearly always indicates the presence of metastases to the nodes. A radical neck dissection is indicated in the surgical treatment of most of these patients who are otherwise operable (primary lesion can be removed).

In our experience at least one-third of patients with carcinoma of the thyroid but without palpable cervical lymphadenopathy do have metastases to the cervical nodes. Whether or not cervical node dissections should be used for these patients is, therefore, not decisively established. However, a modified neck dissection is considered justified in the surgical treatment of many of this group of patients and better results are suggested if it is done.

A modified neck dissection has been defined as a dissection which is identical to the classical radical neck dissection except for the preservation of the sternocleidomastoid muscle and the submaxillary gland area. This includes removal of the nodes adjacent to the thyroid and presupposes complete removal of the primary lesion.

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Construction of Artificial Tendon Sheaths in Dogs

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INVESTIGATIVE procedures designed to limit postoperative peritendinous adhesions are of two general categories: (1) creation of a tunnel by a tubular mold, thereby providing a gliding surface for the tendon after the mold is removed, or (2) ensheathment of the tendon with a substance that prevents adhesions between tendon and surrounding tissue during healing. We investigated the latter procedure and used autologous vein grafts in dogs as artificial tendon sheaths to evaluate the method as a means of preventing peritendinous adhesions at and about sites of fracture.

MATERIALS AND METHODS

Seventeen dogs which weighed between 10 and 12 kg. underwent operations on a total of twenty-nine limbs. Fourteen of these were control limbs. The dogs were killed at intervals of twenty to 112 days.

The extensor carpi radialis tendon was used for all procedures. This tendon is surrounded by paratenon, but also has a true sheath in its distal portion where it lies under the abductor pollicis longus tendon.

All vein grafts were obtained at the time of operation from one of the jugular veins of the same dog. A segment one and a half inches long was removed. All tendon and vein sutures were sutured with No. 5–0 black silk. Bunnell's technic and needles were used for the tendon anastomoses. Fixation was achieved with Kirschner wires or plaster casts or both.

Two groups of animals were used.

Group 1. In this group of eleven dogs, seventeen extremities were operated upon. The following procedures were performed.

1. An inverted vein graft was slipped over free tendon grafts and simple tendon sutures. The inverted venous tubes were sutured to tendons above and below the anastomoses.

2. This resembled the first procedure, but the inverted vein was sectioned longitudinally as well, and was then sutured loosely together. This method re-established the venous tube with openings between sutures.

3. One and a half inches of tendon was stripped of paratenon and peritenon. It was then scarified with a scalpel. The inverted vein was then laid over a tendon as in the second procedure and was sutured to the tendon above and below the traumatized area.

There were eight controls for this group. In these the same operative procedure was performed on the opposite foreleg, but no vein was used.

Group 2. In this group of six dogs, twelve extremities were operated upon. A rectangular piece of periosteum of the radius was excised. Three diagonal incisions were made on the exposed anterior radial cortex with a Stryker saw. The previously removed vein graft was incised and laid open over the incisions in the bone, with the intima facing away from bone. The vein was sutured to the periosteum and the tendon (extensor carpi radialis longus) then glided over the intima in the normal course of the tendon on the radius. The opposite foreleg was used as a control.

RESULTS AND CONCLUSIONS

Placement of an inverted encircling vein graft over a tendon graft or anastomosis resulted in several observations and conclusions. All the tendons were devitalized to some degree, but this was not related to the type of procedure. All the vein grafts fragmented and some

became unrecognizable as veins. Fibrous-tissue reaction generally was greater when a vein was placed around the tendons than it was in the controls. Results of this study and studies of other recent investigators suggest that paratenon and peritenon are responsible for tendon healing.

Autologous venous tissue served as a membrane barrier when placed over a site of fracture. With the venous intimal surface placed toward an adjacent tendon, this material served as a smooth gliding surface and prevented encroachment of bone and fibrous tissue on the tendon.

Traumatic Rupture of the Spleen

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TRAUMATIC rupture of the spleen is a true surgical emergency. It is the most common major, nonpenetrating, abdominal injury in man and is most often caused by the steering wheel and dashboard in automobile accidents. A knowledge of the signs and symptoms of traumatized spleen is important to anyone who treats injured patients.

The signs and symptoms found in seventy-one patients with traumatic rupture of the spleen treated in Hurley Hospital during the period between January 1, 1948 and December 31, 1958 are reviewed herein. Problems encountered in preoperative, operative, and postoperative management will be discussed.

INCIDENCE

Forty-three patients (60 per cent) were male and twenty-eight (40 per cent) were female. The predominance of males has also been reported by other investigators [*3,6,7,11,13,15, 16,21,23*]. The youngest patient in our series was a four year old boy and the oldest a seventy-three year old man. Fifty-seven cases (80 per cent) were between eleven and fifty years of age. (Table I.) Occupations and preoccupations of the male and greater exposure in the young adult account for the sex and age distribution.

TABLE I
AGE DISTRIBUTION

Age Group (yr.)	No. of Patients*
0–10	6
11–20	19
21–30	16
31–40	11
41–50	11
51–60	2
61–70	3
71–80	3

* Total number, 71.

ETIOLOGY

Causal factors are indicated in Table II. The automobile was the greatest offender. Of the total number of patients, 78 per cent were involved either as vehicular occupants or as pedestrians. Prior to 1921 accidents with the horse and wagon were the leading cause [*15*].

The next most common cause of injury was penetrating wounds. Five of these were gunshot wounds of the left upper abdomen and left lower chest. One victim received ten stab wounds in the left upper quadrant and left rib cage. Falls accounted for five cases: two fell against the bathtub, one fell on ice, one fell into an open manhole, and one fell into a six-foot pit.

A history of trauma was not obtained in one instance. This forty-five year old man was admitted to the hospital on January 24, 1952.

TABLE II
ETIOLOGY

Cause		No. of Patients*
Automobile accidents		54
Vehicle occupants	50	
Pedestrians	4	
Penetrating wounds		6
Gunshot wound	5	
Stabbing	1	
Falls		5
Blows and kicks (fighting)		2
Blows by moving objects (struck by handle)		1
Miscellaneous		2
Unknown		1

* Total number, 71.

FIG. 1. A reproduction of Dürer's self-portrait indicating pain in the region of the spleen [2].

Abdominal pain, distention, and fullness unrelated to meals had persisted for one week. He also complained of anorexia and constipation. Upon admission the abdomen was rigid and tender. No masses were palpated. A preoperative diagnosis of perforated peptic ulcer was considered. However, laparotomy revealed a clot which measured 15 to 18 cm. in diameter in the splenic region. The spleen weighed 90 gm. and was grossly unremarkable except for a rent in the hilus. The capsule was smooth and the surface was congested on cut section. Microscopic sections of spleen revealed only a mild hyperplasia of the reticulum. The heterophil agglutination test was negative and the rupture was unexplained. Orloff and Peskin [*14*] reported only twenty-eight cases of spontaneous rupture of the normal spleen in a recent review of all cases published in English.

SYMPTOMATOLOGY

"On the yellow spot where I point my finger, there I have pain." [2] These were the words scribbled on a self-portrait by Albrecht Dürer. He sent this drawing to his doctor in the year 1520 when he was suffering from quartan fever and probably had an enlarged and painful spleen. (Fig. 1.)

TABLE III
ONSET OF SYMPTOMS

Time of Onset	Patients*	
	Number	Per cent
First 24 hours	44	70
Second 24 hours	7	17
Delayed 2 to 12 days	12	19
Total	63	100

* Splenectomy was performed on sixty-three patients.

Pain in the left upper quadrant was present in twenty-nine patients (43 per cent), generalized abdominal pain was reported by eighteen (27 per cent), epigastric pain by five (7 per cent), and right upper quadrant pain by two (3 per cent). Fifty-four patients (81 per cent) complained of abdominal pain. Pain in the left shoulder (Kehr's sign), which Tagart [*20*] considers by far the most reliable single sign of ruptured spleen, was present in only seventeen (25 per cent) of the patients. Pain in the left lower chest was described in eighteen patients (27 per cent). This was due to associated fractured ribs. Since many patients had a number of associated injuries, a variety of symptoms were given which will not be enumerated. Five patients were unable to give any history because of severe craniocerebral injuries.

Symptoms immediately followed trauma or occurred within the first twenty-four hours in forty-four patients (70 per cent). Seven patients (17 per cent) had no symptoms until the second twenty-four hours after trauma. Thus, signs and symptoms developed in fifty-one patients

TABLE IV
PROMINENT ABDOMINAL FINDINGS

Sign	Patients	
	Number	Per cent
Generalized tenderness	31	43
Marked tenderness in left upper quadrant	29	40
Bowel sounds absent	25	35
Distention	20	28
Rigidity	20	28

(80 per cent) within the first forty-eight hours after trauma. Twelve patients (19 per cent) represented true delayed ruptures of the spleen according to the criteria of McIndoe [13]. In these patients, signs and symptoms were delayed for more than forty-eight hours after trauma. Two to twelve days elapsed before the diagnosis of occult splenic injury and hemorrhage was made. (Table III.)

SIGNS

The prominent abdominal findings are listed in Table IV. Abdominal tenderness was present in sixty-two patients (87 per cent). Thirty-one of these had generalized abdominal tenderness, twenty-nine had maximal localized tenderness with rebound in the left upper quadrant, and two had marked tenderness in the upper right quadrant. Four patients did not have abdominal tenderness. Ballance's sign (fixed dullness in the left flank and shifting dullness on the right) was observed in three patients. A mass in the left upper quadrant was palpated in only two cases. Bowel sounds were absent in twenty-five cases. Visible trauma to the skin of the anterior abdominal wall was evident in seven cases, five of which were gunshot wounds. One patient had a simple contusion of the left upper quadrant. Evidence of shock was present in thirty-one patients (43 per cent) when they were admitted. The rest were normotensive but some evidence of hemorrhage developed later.

ASSOCIATED INJURIES

Injury to the spleen without associated injuries was present in twelve cases (16 per cent). Fracture of the ribs on the left side (notably the eighth, ninth, and tenth, posteriorly) was the most common associated injury. It was observed in twenty-three cases (32 per cent) in our series. Fractures of the extremities were present in nineteen patients (26 per cent). Twelve of these had fractures of the lower and seven of the upper extremities. There were sixteen patients (22 per cent) with moderate to severe craniocerebral injuries. In fifteen patients (21 per cent) other abdominal viscera also were lacerated. There were nine instances of pulmonary contusion, and seven of ruptured left hemidiaphragm with hemothorax in six. Contusion of the left kidney was assumed to be present in eleven patients (15 per cent) whose urine was grossly bloody without other evidence of injury to the genitourinary system. The urinary bladder was ruptured in one instance. (Table v.)

TABLE V
ASSOCIATED INJURIES*

Type		Number
Fracture of ribs†		26
Left posterior	23	
Right side	3	
Fracture of extremities		19
Upper	7	
Lower	12	
Other fractures‡		11
Craniocerebral injuries		16
Other lacerated abdominal viscera		15
Pulmonary contusion		9
Contusion of left kidney		12
Lacerations of skin and contusions		12
Hemothorax		7
Left	6	
Right	1	
Rupture of left diaphragm		7
Pneumothorax		6
Left	5	
Right	1	
Rupture of pericardium		1
Total		147

* Seventy-one patients with traumatic rupture of the spleen.
† Notably eighth, ninth and tenth.
‡ Skull, clavicle, vertebrae, pelvis or scapula.

LABORATORY AIDS

Laboratory tests help in the evaluation of patients with acute abdominal trauma. Complete blood count, urinalysis, and roentgenograms of the chest and abdomen should be done when the patient is first seen in the emergency department. A Levin tube and Foley catheter should be inserted before the patient is taken to the x-ray department. Hemoglobin determinations on admission are vital since subsequent determinations can be valuable if there is a progressive decrease in hemoglobin concentration.

Determinations of hemoglobin values were done on admission in sixty-eight of the patients in this series. Ten indicated a significant deficit (hemoglobin below 10 gm. per cent); twenty-one showed a moderate anemia (10 to 12 gm. per cent) and thirty-seven were satisfactory (above 12 gm. per cent).

A leukocyte count was taken in sixty-two patients. The total count ranged from 5,800

A B C

FIG. 2. A, flat plate of the abdomen reveals adynamic ileus, increased intra-abdominal fluid and increased haziness in the left upper quadrant. B, flat plate of the abdomen reveals a marked increase in the size of the splenic shadow with downward displacement of the colonic splenic flexure. C, anterioposterior roentgenogram of the splenic region showing evidence of fractured ribs (eight through eleven).

to 46,900 cells per cu. mm. Forty-eight patients (77 per cent) had a total leukocyte count above 10,000 per cu. mm. with a shift to the left in the differential count. Twenty-one of these had a total count above 20,000 per cu. mm. The white blood cell count was within normal limits in only fourteen cases.

Berman et al. have found that if the white corpuscles number more than 15,000 per cu. mm. in a patient with a nonpenetrating abdominal injury, the patient probably has a lacerated liver or spleen. They reported a degree of accuracy of 95 per cent with this method.

TABLE VI
ROENTGENOGRAPHIC SIGNS*

Sign	Times Present	
	Number	Per cent
Gastric dilatation with adynamic ileus	10	40
Left upper quadrant density	8	32
Increase in abdominal fluid	3	12
Elevation of left hemidiaphragm	2	.08
Medial displacement of stomach bubble and downward displacement of splenic flexure	1	.04
Serration of greater curvature of stomach	1	.04
Total	25	100

* Twenty-five patients with splenic rupture.

Urinalyses were obtained in sixty cases, twelve of which revealed grossly bloody urine. The other forty-eight urinalyses were essentially normal.

Roentgenograms of the abdomen were taken of forty-eight patients upon admission. Of these, fourteen (29 per cent) revealed no significant findings. Twenty-five (52 per cent) demonstrated presumptive injury to the spleen based upon one or more of the following findings: (1) gastric dilatation with adynamic ileus (Wyman [23] reported gastric dilatation to be the most frequently encountered roentgenographic sign in his series), (2) increased density in the left upper quadrant or in the size of the splenic shadow, (3) increase in abdominal fluid, (4) elevation of the left hemidiaphragm, (5) medial displacement of the stomach and downward displacement of the colonic-splenic flexure, and (6) serration of the greater curvature of the stomach. (Table VI and Fig. 2.)

In twenty-three cases abdominal films were omitted since treatment was clearly indicated on clinical grounds.

Paracentesis to determine the presence of free blood was performed on ten patients; free blood was found in six. This procedure can be of great value when properly done. However, a dry peritoneal tap does not exclude splenic rupture.

PREOPERATIVE DIAGNOSIS

A correct preoperative diagnosis of traumatic rupture of the spleen was made in thirty-seven (59 per cent) of the sixty-three patients sub-

TABLE VII
RATE OF ACCURACY IN PREOPERATIVE DIAGNOSIS

Preoperative Diagnosis	Patients	
	Number	Per cent
Traumatic rupture of the spleen	37	59
Intra-abdominal hemorrhage, spleen considered	12	19
Ruptured mesentery	2	.03
Retroperitoneal hemorrhage from lacerated kidney	2	.03
Ruptured diaphragm	2	.03
Ruptured urinary bladder	2	.03
Gunshot wound	5	.09
Perforated ulcer	1	.01
Total	63	100

TABLE VIII
COMPLICATIONS

Early	No. of Times Present
Postoperative ileus	6
Left pleural effusion	5
Wound abscess	2
Evisceration	1
Other*	7
Total	21
Late	
Incisional hernias	2
Splenosis	1
Total	3

* Thrombophlebitis, fecal fistula, jaundice, cardiac arrhythmia, subhepatic abscess, left subphrenic abscess, large bowel obstruction (one each).

mitted to splenectomies. (Table VII.) In twelve cases a diagnosis of intra-abdominal hemorrhage was entertained and rupture of the spleen was one of the considerations.

TREATMENT

Once the diagnosis of splenic rupture is made, immediate splenectomy with blood replacement is the treatment of choice. Delay in operation increases morbidity and mortality. In our series, forty-four patients (70 per cent) were operated upon within an average time of six and three-quarter hours from the moment they first entered the emergency department.

A left upper paramedian incision was preferred and was used in thirty-four of these patients. It provides adequate exposure for exploration of the entire abdomen. Splenectomy was performed through a transverse incision in the left upper quadrant in ten patients and through a left subcostal incision in nine patients. In two patients splenectomy was performed through thoracotomy incisions. The midline incision has also been used.

Blood transfusion was required by all patients except one. The average amount administered to each patient was 1,706 cc. One patient received a total of 6,000 cc. of blood during and after the operation.

It is not necessary to drain the abdominal cavity following splenectomy. The placement of drains is no substitute for adequate hemostasis. Their use is related to other circumstances, such as perforation of the bowel or risk of continuing contamination. The operative area in nine of the patients in this series was drained through a stab wound in the left upper abdomen.

The average length of hospitalization for fifty-five patients who fully recovered from their splenectomies was eighteen days.

COMPLICATIONS

There were twenty-one early and three late postoperative complications. (Table VIII.) The early complications included six cases of postoperative ileus; one also had a very severe electrolyte and fluid imbalance, associated with "traumatic wet lung," resulting in death. The other five recovered with gastric intubation and intravenous fluids. Five patients had left pleural effusions, but only one required aspiration. Two wound abscesses were managed by incision and drainage, soaks, and antibiotics. One patient suffered spontaneous evisceration on the fifth postoperative day. This was repaired with through and through retention sutures. Ten days later the same patient developed severe uremia secondary to lower nephron nephrosis (blood urea nitrogen, 387 mg. per cent) and died.

The most severe and common complication with associated injury to the chest was left "traumatic wet lung." This included pulmonary contusion (nine), retention of secre-

TABLE IX
ANATOMIC TYPE OF TRAUMATIC RUPTURE OF THE SPLEEN

Type	Patients	
	Number	Per cent
Laceration through the capsule into the parenchyma	52	73
Fragmentation	9	13
Subcapsular and intrasplenic hematomas	4	.06
Laceration of the splenic pedicle	3	
With avulsion	2	
Without avulsion	1	.04
Perisplenic hematoma with a posterior tear	2	.03
Puncture wound	1	.01
Total	71	100

tions and obstructive atelectasis (six), and pneumonia (four).

There was one of each of the following complications: thrombophlebitis, fecal fistula, jaundice, cardiac arrhythmia, subhepatic abscess, left subphrenic abscess and large bowel obstruction.

A low grade fever for several days postoperatively was the rule. This is probably related to absorption of blood retained in the abdominal cavity.

Late postoperative complications included two incisional hernias and one splenosis. The occurrence of multiple implantations of splenic tissue throughout the abdominal cavity in man is an interesting phenomenon. The first case of traumatic splenic implant was reported by Kutner in 1910 [*10*]. A recent review of the literature by Cotlar [*4*] brought the total number of recorded cases of splenosis to thirty-six.

One of the patients whom we treated was an eighteen year old white girl who was involved in an auto accident in which she received abdominal and head injuries on January 13, 1951. Upon admission she was unconscious and her blood pressure was imperceptible. She regained consciousness following transfusion. The blood pressure increased to 120/70 mm. Hg and remained stable. The patient then felt comfortable. On the following morning she became weak, confused, and restless. Her skin was pale, cold, and clammy. There was evidence of severe shock. The abdomen was moderately distended and tender. Fluid wave was elicited and no bowel sounds were heard. She was taken to the operating room with the diagnosis of intra-abdominal hemorrhage. At laparotomy a hemoperitoneum (3,000 cc.) and a large, deep stellate type of laceration of the spleen were found. Splenectomy was performed. The postoperative course was uneventful and the patient was discharged eighteen days after admission.

Approximately six years later (April 18, 1957), this patient was admitted to the hospital and operated upon for uterine fibroids. These proved to be a splenic implant at operation. This was confirmed by gross and microscopic pathologic reports of normal splenic tissue.

PATHOLOGY OF SPLENIC RUPTURE

Single or multiple lacerations of the capsule into the parenchyma were found in fifty-two splenic specimens. There were three lacerations of the splenic pedicle, two with a complete avulsion of the spleen. Fragmentation of the spleen into two or more pieces was found in nine patients. There were four subcapsular and intrasplenic hematomas without capsular break. Two fairly well organized perisplenic hematomas with a posterior splenic tear occurred in patients with delayed ruptures. There was one through and through puncture wound of the spleen. In this patient a bullet went through the left elbow, fractured the distal end of the humerus, entered the abdomen through the left flank, perforated the spleen and was found lying free on the posterior parietal peritoneum in the left colic gutter. (Table IX.)

MORTALITY

Of seventy-one patients treated for splenic rupture, eight died before operation. Death in these cases was due to severe associated injuries, especially craniocerebral and crush injuries to the chest, rather than to splenic rupture alone. The diagnosis of splenic rupture was confirmed by necropsy in these cases.

There were eight operative deaths (12 per cent). Two of these patients, the youngest and the oldest, died on the operating table. The youngest was a four year old boy who was a victim of an auto accident two days prior to operation. While the peritoneum was being closed following splenectomy, the patient developed cardiac arrest. Thoracotomy and cardiac massage failed to revive the child.

TABLE X
OPERATIVE MORTALITY IN SPLENECTOMIES

Author	Year	No. Reported	Mortality (Per cent)
Wright and Prigot	1939	22	22.7
Foster and Prey	1940	12	33.3
Rousselot and Illyne	1941	17	29.4
Harkins and Zabinski	1943	10	30.0
Roettig et al.	1943	11	9.0
Scott and Bowman*	1946	7	0.0
Larghero and Giura	1951	18	5.5
Knapp and Harkins	1954	21	23.8
Mansfield	1955	16	0.0
Terry et al.	1955	93	17.0
Parsons and Thompson	1956	23	0.0
Present series	1959	63	12.0

* Patients under eight years of age.

The other patient who died on the operating table was a seventy-two year old man who had had diabetes for many years. He was also a victim of an auto accident. He died immediately after splenectomy. The associated injuries in this case were: fracture of the left clavicle, fractured ribs on the left and contusions of the left lung.

Two patients died on the first postoperative day, one of irreversible shock and the other of multiple fractures and internal injuries. One death occurred on the seventh postoperative day due to obstructive atelectasis, postoperative ileus, and electrolyte and fluid imbalance. One death occurred on the eleventh postoperative day due to cerebral concussion, fractured ribs, right traumatic wet lung, pneumonia, and hematuria. Two patients expired on the twelfth postoperative day. One death was attributed to a lower nephron nephrosis with superimposed severe uremia. The other patient developed pneumonia, pleural effusion, jaundice, and hyperpyrexia (105.6°F.).

The operative mortality of our sixty-three patients who had splenectomy was 12 per cent and the over-all mortality (seventy-one patients) was 25 per cent. (Table X.)

EXPERIMENTAL CONSIDERATION OF PENETRATING SPLENIC WOUNDS

Sharp penetrating wounds to the spleen may produce only moderate amounts of free blood in the abdominal cavity. This was exemplified by a stab wound of the spleen in one of our patients and a bullet wound in another. In both, the amount of intraperitoneal hemorrhage was minimal. Blunt trauma which was sufficient to rupture the spleen caused considerable more bleeding.

FIG. 3. Photograph of a dog's spleen with a sharp cut produced by a scapel. Note the minimal amount of bleeding produced.

An attempt to reproduce the two types of splenic rupture was made in the laboratory. Figure 3 is a photograph of a dog's spleen with a sharp cut produced by a scalpel. The bleeding was brisk for a moment, then gradually subsided. A gradual decrease in the size of the spleen was noted. The spleen was immediately replaced into the peritoneal cavity and the abdominal wall was closed. Three animals were subjected to this procedure. Hemoglobin values decreased 1.5 to 2 gm. per cent with a minimal drop in hematocrit. These animals were sacrificed five days later. There was no evidence of persistent bleeding. The spleen was noted to be very small. Cut edges were less than 1 cm. apart and bridged over by well formed, smooth clot. The amount of free blood in the abdominal cavity was less than 100 cc.

FIG. 4. A dog's spleen injured with a blunt crushing force produced by a retractor. Note the severe hemorrhage.

Figure 4 represents a dog's spleen injured with a blunt, crushing force produced by a retractor. Bleeding was more profuse and continued longer than when the injury was produced by a sharp cut. All three animals subjected to this procedure expired within forty-eight hours after surgery. At necropsy the spleen was small and surrounded by a large clot. Massive hemoperitoneum was present. Davis et al. [5] reported a similar experimental work with sharp and blunt trauma to the spleen but none of the sixteen dogs in their series died from immediate or delayed hemorrhage.

COMMENTS

Splenic injuries are common and the diagnosis is not usually difficult if the indications of this type of injury are kept in mind. Fractured ribs may direct attention to the underlying spleen since this was the most common associated injury.

This relationship between the rib cage and the spleen is apparently a factor when considering the proneness of the spleen to rupture. The spleen is held in its position by the various peritoneal folds. These include attachments to the diaphragm, presplenic fold, gastrosplenic and splenorenal ligaments. When the energy of external trauma is transmitted from the chest wall to the underlying spleen, the latter is held in a relatively fixed position and the splenic parenchyma is torn. This type of wound tends to remain open and the bleeding persists. It is comparable to the experimental situations previously described. The relatively soft, pulpy nature of the substance of the spleen adds risk of injury.

Further anatomic considerations which probably contribute to this problem are the rather long splenic vessels and their poor support at the hilum of the spleen. These vessels or their major hilar branches may be avulsed, particularly with blunt trauma to the upper abdomen.

The liver and kidneys have a firmer, less vascular parenchyma. They possess better protection for their major vessels and are not as prone to rupture. In our series there was only one case of ruptured left kidney.

Iatrogenic rupture of the spleen does occur at surgery. However, we have been unable to determine accurately the number of times this has occurred. Therefore, no attempt was made to correlate these with our present series.

SUMMARY

1. Problems in diagnosis and management of seventy-one cases of traumatic rupture of the spleen seen in Hurley Hospital in a ten-year period are presented.

2. Rupture of the spleen is the most common of all major abdominal injuries in man. The fixed anatomic location and the soft, friable nature of the spleen are responsible for its susceptibility to rupture and subsequent hemorrhage.

3. This injury is more frequent in males by a ratio of about two to one. The male between eleven and fifty years of age is most commonly afflicted.

4. Automobile accidents account for 78 per cent of the cases reported. Penetrating wounds of the abdomen and falls are the next most frequent causes of splenic rupture.

5. Abdominal pain is the outstanding complaint. Pain in the left shoulder (Kehr's sign) occurred in only 25 per cent of the patients. The symptoms occurred within the first twenty-four hours after trauma in 70 per cent of the cases.

6. The most prominent abdominal finding was generalized or localized tenderness in the left upper quadrant. Fixed dullness in the left flank and shifting dullness in the right (so-called Ballance's sign) was an extremely rare finding.

7. Injury to the spleen alone is unusual.

8. The most common associated injury was fractured ribs, eight, nine, and ten on the left. Fractured extremities were the next most common associated injury. The most serious and

commonly found complication of the associated injuries was left "traumatic wet lung."

9. Severe anemia upon admission was found in less than 50 per cent of the patients; however, a reduction in hemoglobin after admission was significant in the evaluation of intraabdominal hemorrhage. The white blood cell count was elevated above 10,000 per cu. mm. in over 65 per cent of the patients. A shift to the left in the differential count was present in all. Urinalysis was helpful only in eliminating genitourinary injury.

10. Prominent roentgenographic signs were gastric dilatation with adynamic ileus and density in the left upper quadrant. A suspected or definite diagnosis of splenic rupture can be made from roentgenograms in 50 per cent of the cases.

11. The immediate postoperative complication most commonly found was adynamic ileus. A late postoperative complication of splenosis is reported.

12. Lacerations to the capsule and the parenchyma of the splenic tissue were found in over 70 per cent. Sharp laceration and stab wounds of the spleen produced minimal hemorrhage.

13. Lacerations produced by blunt trauma result in more severe hemorrhage and shock than injury caused by a sharp object.

14. The treatment for splenic rupture is splenectomy with blood replacement. All but one of the patients required blood transfusions. The average amount given to each one was 1,706 cc.

15. The operative mortality was 12 per cent and the over-all mortality was 25 per cent.

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CASE REPORTS

Gas Gangrene of the Brain

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GAS gangrene of the brain is an unusual disease entity. A review of the medical literature reveals that no cases have been reported in the American or British literature in the past ten years, while the German literature contains reports of two cases [2].

Gas gangrene in the human is usually caused by a mixed bacterial flora. In the majority of cases the organisms cultured have been gram-positive cocci, gram-negative rods, and gram-positive rods. The Clostridium perfringens has been identified in about 75 per cent of a reported series of gas gangrene [10]. An anerobic Streptococcus, a Diphtheria bacillus, and an Actinomyces have been incriminated as the main pathogens in certain of the reported cases of gaseous myositis [3,5].

While the majority of cases involve the lower extremities reports are available of cases involving primarily the uterus, the liver and other unusual areas [4,6]. There is general agreement that this disease can not become manifest, primarily, unless there is available traumatized or devitalized tissue to serve as the host culture medium. These requirements have been demonstrated clearly by Ascroft and Pulvertaft [1]. In their report, cultures made from open wounds repeatedly yielded growth of C. perfringens, but the patients did not develop gas gangrene as a clinical entity. This disease is, therefore, a clinical diagnosis and not solely a diagnosis predicated upon reports of bacteriologic cultures.

Traumatized muscle seems to be the best culture medium for clostridia, especially under anerobic conditions. Edema, loss of contractility, and crepitation are found typically in affected muscle tissue. Due to fermentation of sugar, gas is formed which can be expressed from the tissue.

The disease spreads systemically and locally once toxins are produced. The alpha toxin, which has been identified as lecithinase C, is the one most commonly affecting man [10]. This toxin diffuses into previously unaffected tissues causing hemolysis and necrosis. This permits further extension of the organisms into new areas of reduced oxygen tension. The toxemia usually precedes the formation of clinically recognizable tissue crepitation. A rapidly developing hemolytic anemia is frequently noted as this occurs.

Coexistent systemic problems such as malnutrition, anemia, arteriosclerosis, diabetes mellitus and shock have been observed to enhance the development of gas gangrene [6]. Extensive muscle damage, major vascular injury associated with an unevacuated hematoma, tight circular dressings, ill-fitted casts, and inadequate debridement are factors of local importance [9]. While these have been described with particular reference to war casualties, they certainly are applicable to any injury.

The prognosis of this disease has improved greatly in recent years. Petit reported that the incidence of gas gangrene was 5 per cent of the 4,377 casualties he saw in World War I [8]. Of this group 27.6 per cent expired. In World War II a report by North from an American hospital in India revealed the incidence of gas gangrene to be 0.7 per cent in 4,650 cases [7]. The mortality rate in that series was 31.3 per cent. In the Korean War, Howard and Inui reported an incidence of 0.81 per cent of 4,900

FIG. 1A. Anterioposterior view of skull on admission.

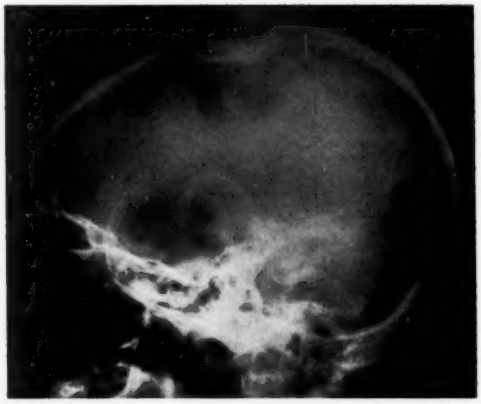

FIG. 2B. Lateral view of skull on admission. Both A and B reveal the markedly depressed fracture overlying the gas filled cavity.

casualties [5]. There were no deaths in this series. In the report of Prout and Brown of 9,000 casualties during the Korean conflict, the incidence of the disease in their series was 0.166 per cent [9]. One patient in this group died, a mortality of 6.6 per cent.

CASE REPORT

On January 1, 1959, a forty-one year old Negro man was struck over the right parietal area with a cement block. He was brought to the Emergency Room of the Jackson Memorial Hospital. The patient denied any period of unconsciousness. Examination at that time revealed a laceration 3 inches long on the right parietal area. The neurologic examination was within normal limits. Contrary to the usual procedure, no roentgenograms of the skull were obtained. The laceration was closed with a single layer of silk sutures and tetanus toxoid was administered. The patient was discharged with instruction to return in one week.

Two days after injury the patient developed a left hemiplegia, and some hours later had a focal seizure of the face with "foaming at the mouth." On January 4, 1959 he was admitted to the Neurological Surgery Service of the Jackson Memorial Hospital.

Physical examination revealed a well developed, well nourished Negro male in moderately acute distress. He was alert, cooperative and followed commands. The blood pressure was 128/98 mm. Hg, the pulse was 100, respiratory rate was 22, and the temperature was 101°F.

Pertinent physical findings included a laceration of the right parietal area approximated with silk sutures. The surrounding scalp area was warm, tender, and erythematous. No crepitation was noted. There was paralysis of left conjugate gaze. The tongue deviated to the left and there was weakness of the left palate. Moderate nuchal rigidity was present. There was a left hemiplegia. Sensation was intact bilaterally to pin prick and touch. The deep tendon reflexes were equal and physiologic in the lower extremities; they were somewhat depressed in the left upper extremity. A Babinski reflex was present on the left.

Pertinent laboratory data on admission included the following: hemoglobin, 11.5 gms. per cent; hematocrit, 42.5 per cent; leukocyte count, 12,900 per cu. mm. Differential leukocyte count revealed the following: segmented neutrophils 69 per cent, stabs 16 per cent, lymphs 15 per cent. Urinalysis revealed specific gravity of 1.019, albumin 100 mg. per cent, sugar and acetone negative, pH 6.0, white blood cells 8 to 15 per high powered field and red blood cells 3 to 5 per high powered field.

X-ray films of the skull revealed a depressed fracture of the right anterior parietal region. The fragment measured 3 by 4 cm. and was depressed 1½ cm. below the inner table. Gas bubbles were apparent. (Fig. 1A and B.)

The patient was immediately taken to the operating room. He was given endotracheal anesthesia. A horseshoe shaped frontoparietal flap was turned. The edges of the previous wound were excised leaving an ellipse in the center of the flap. There was cellulitis with marked thickening and

FIG. 2. Lateral roentgenogram of skull shows rubber catheters in the abscess cavity and subgaleal space.

edema of the regional scalp. Bubbles of gas, foul purulent material, and necrotic brain were seen to be exuding from the fracture site. All involved bone was removed. There was a 3 by 4 cm. stellate laceration of the dura through which a large fragment of bone protruded into the cortex of the anterior parietal lobe. The abscess cavity measured 3 by 3 by 4 cm. and contained purulent material, necrotic brain, and some hematoma. There was no definite capsule, the cavity being surrounded by white matter slightly more firm than normal. All grossly infected and necrotic material was removed. Catheters were placed in the abscess cavity and subgaleal space for injection of a solution of 1 per cent Neomycin® and 50,000 units of Bacitracin®. (Fig. 2.)

A gram-stain performed during surgery revealed multiple organisms, one of which was large gram-positive rods. The wound was closed with through and through wire sutures.

Because of the problem of excessive secretions during the operation and the anticipated difficulty in adequately caring for the tracheobronchial secretions in the early postoperative period, a prophylactic tracheostomy was performed.

Culture revealed a gram-negative rod, Paracolobacterium, and a gram-positive anerobic rod having the cultural and biochemical characteristics of Clostridium perfringens. A guinea pig innoculated with a specimen of the Clostridium colony died within twelve hours.

The immediate postoperative period was quite stormy and the patient did not appear to be reasonably responsive until the fourth postoperative day. The tracheostomy tube was removed as soon as the bronchorrhea subsided.

On the eighth postoperative day the patient had a generalized seizure and became semi-comatose. A lumbar puncture revealed an initial pressure of 275 mm. H_2O. The cerebrospinal fluid was xanthochromic and contained 78 leukocytes per cc.; 58 per cent were segmented cells and 42 per cent mononuclear cells. Sugar was 72 mg. per cent and protein was 140 mg. per cent. Gram-stain and culture failed to demonstrate any organism.

Chloromycetin was added to the antibiotic regimen because the original sensitivity studies indicated its *in vitro* effect on the C. perfringens organism. The patient improved rapidly, becoming responsive, coherent and afebrile. On the tenth postoperative day the last catheter was removed, after the final injection of the Neomycin and Bacitracin solution.

On the twenty-sixth postoperative day some purulent drainage was noted from the area of the incision. A scalp abscess was evacuated and the scalp flap revised. Culture of the abscess revealed Staphylococcus aureus, coagulase positive. Chloromycetin therapy was continued and the patient remained afebrile. No further drainage from the scalp was noted.

On April 24, 1958, the patient was discharged. He has a residual left hemiplegia and is receiving physical therapy in the outpatient department.

COMMENTS

A patient with a history of trauma to the head should be questioned in detail, when at all possible, regarding the nature of the accident. Size, shape and weight of the damaging object obviously are significant. An attempt to ascertain the force of the blow will yield helpful information relative to the severity of the damage.

The case presented herein demonstrates clearly the possible disastrous consequences of neglect of a seemingly trivial head injury. It is not our intention to discuss the considerations of intracranial bleeding and direct cerebral injury as the result of head injury. However, the case does present the need for discussion of the management of injuries to the scalp and skull in the emergency room. The only absolutely accurate method of diagnosing depressed fractures of the skull, whether compound or simple, is by roentgeongram. Too often the gloved examining finger reports the sharp edge of the cut galea as a depressed fracture.

Rather severely depressed fractures of the inner table frequently are overlooked because of only relatively minor depression and distortion of the outer table on direct inspection or palpation. For this reason it is urged that roentgenograms of the skull be obtained in any case of direct force injury which has been sufficient to lacerate the scalp. In lieu of x-ray prior to surgical closure of the scalp wound, we believe it is essential that the depths of the wound be clearly visualized even if it is necessary to extend the wound slightly. The scalp should be shaved in an area at least one and a half to two inches in all directions surrounding the laceration. Devitalized and crushed tissue should be debrided after thorough cleansing of the surface of the wound with a mild detergent and sterile saline. We have found that block anesthesia surrounding the wound facilitates and allows for more thorough cleansing of the wound. Following thorough cleansing and debridement the surgeon should inspect the depths of the wound thoroughly. If the galea and periosteum are intact they need not be opened. If the periosteum and galea are not intact they should be opened as widely as necessary to thoroughly inspect the outer table of the skull for any evidence of fracture. After thorough inspection and copious irrigation the wound is closed in two layers, first the galea and then the skin. In the absence of preliminary roentgenograms it is believed that this procedure should be performed in the operating room so that further definitive treatment can be instituted immediately if a compound, depressed fracture is found. Compound, depressed fractures of the skull should be treated as soon as possible in the operating room only. The surgeon should be prepared to face a situation in which imbedded bone has lacerated the dura and possibly even the cerebral cortex. Thorough debridement, hemostasis and proper closure of all layers is essential in the correct initial treatment of these injuries.

In this case it is thought that excision of the original wound and extensive debridement of the scalp and skull, plus evacuation of the abscess, was necessary if this patient was to have any reasonable chance for survival. Also, local antibiotic therapy was considered an important part of the postoperative management.

The use of prophylactic tracheostomy in the immediate postoperative period has been described by Starzl, Meyer, and Farrell [*11*]. This was a helpful therapeutic measure because it facilitated removal of the profuse tracheobronchial secretions which might well have caused pulmonary complications. Prophylactic tracheostomy is employed in this hospital for many patients who require surgery for head injury. It is done in the operating room immediately following the craniotomy and we believe it has facilitated postoperative management.

Penicillin and streptomycin were used systemically in the treatment of this case, as is our general policy in the initial treatment of infection due to a probable mixed flora. Only after culture and sensitivity reports are available is consideration directed toward altering the antibiotic regimen.

SUMMARY

1. A brief discussion of gas gangrene is presented with the report of an unusual case involving the brain.
2. The need for meticulous local examination of the patient with a laceration of the scalp is emphasized.
3. The use of local and systemic antibiotics postoperatively and prophylactic tracheostomy is discussed.

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Traumatic Pancreatitis

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THE reported incidence of traumatic pancreatitis as a distinct entity has not been great and the case described herein is sufficiently complete to be of value in establishing this diagnosis for consideration in all abdominal injuries of a nonpenetrating or blunt nature. The various phases of the pathologic progress were anatomically, biochemically and clinically demonstrated as the disease sequence advanced and finally regressed to cure.

CASE REPORT

L. H., a seven year old boy, was admitted to the Bryn Mawr Hospital on February 20, 1956, at 9:30 A.M., with a provisional diagnosis of rupture of the spleen. The child had fallen from a bicycle at noontime on the previous day. He stated that the handle bar had struck his abdomen in the left upper quadrant and that he had had immediate pain in the upper part of the abdomen after the injury. The pain became severe, being mainly in the left upper quadrant, and was accompanied by repeated vomiting and classic evidence of shock.

On admission his temperature was 97.4°F., pulse rate was 82 and respirations 18. The skin was ash-colored and clammy to the touch; he moved very little or in a guarded manner because of abdominal pain. Examination showed a moderate degree of rigidity of the abdominal wall in the epigastric area, with marked localized tenderness in the left upper quadrant. Peristalsis was absent. Rectal examination produced extreme pain on pressure in the rectovesical pouch. Neither spleen not liver was palpable. No note was made as to the presence of the Cullen or Grey-Turner signs. There was no evidence or suggestion of free fluid in the abdominal cavity. No significant tenderness or mass was present in the loins. The white blood cell count on admission was 11,200 per cu. mm., 95 per cent polymorphonuclear cells and 5 per cent lymphocytes; no increase in rods was noted. Hemoglobin was 12.9 gm. per cent with 3,950,000 red cells per cu. mm.; hematocrit was 36.8 per cent. The urinalysis was not significant. There were no red cells present in the urine. Abdominal roentgenogram was not taken. The serum amylase and lipase determinations were not performed preoperatively.

A preoperative diagnosis of rupture of the spleen was made and operation was performed at 2:18 P.M. on February 20. The spleen was found to be normal in all respects, with no evidence of trauma. There was no injury to the duodenum, with particular reference to the third portion of it traversing the vertebral column. The liver was uninjured, as was the stomach. The gallbladder and common bile duct were free from damage. There was a small amount of serosanguineous fluid in the abdominal cavity, diffused throughout the lateral gutters and pelvis. The pancreas was glistening, swollen and edematous, without any gross hemorrhage into it and without any particular discoloration. There were numerous areas of gross fat necrosis in whitish-yellow plaques on the surface of the pancreas retroperitoneally. These areas of fat necrosis were also distributed throughout the gastrocolic omentum and base of the great omentum, over the transverse colon and around the pylorus. Several of these plaques were excised from the gastrocolic omentum for examination. The pancreas was inspected and gently palpated. The abdomen was closed without drainage.

Serum amylase and lipase studies were made immediately after the operation; the amylase was reported as 220 units and the lipase 6 units.

The microscopic examination of the plaques was reported from the pathologic laboratory as "fat necrosis." The postoperative course was generally encouraging; the temperature ranged from normal to 101°F., subsiding to normal levels from March 4 to 7. There was some drainage from the wound on March 3 apparently coming from an intra-abdominal source, presumably the pancreas. Figure 1 indicates the amylase and lipase fluctuations, reaching levels of 922 units and 9.5 units, respectively, on March 5. A fasting blood sugar determination on February 24 was 52 mg. per cent and on March 14 was 98 mg. per cent. Serum calcium on February 25 was 5.2 mg. per cent.

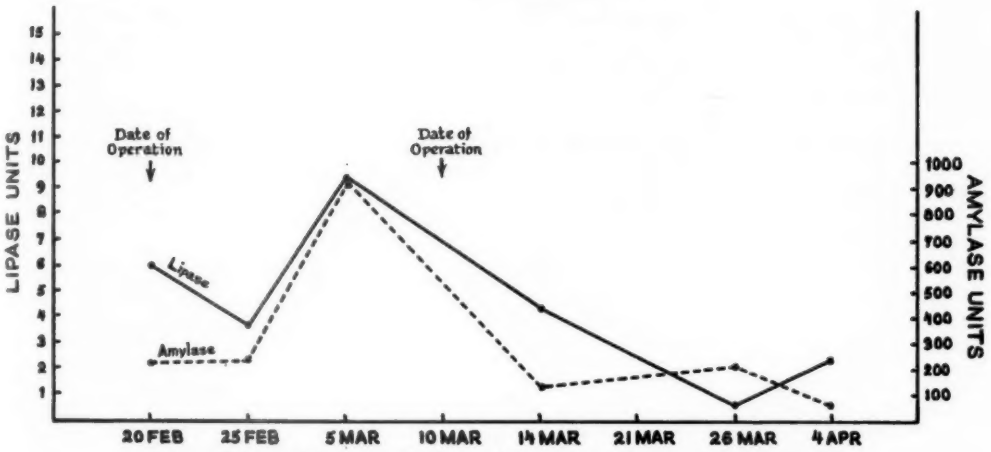

FIG. 1. This graph indicates the fluctuations in serum lipase and amylase levels.

On March 8 he commenced to have marked pain in the left upper quadrant and left flank, with rapidly increasing rigidity and tenderness in this area. No mass could be palpated at this time because of rigidity. The temperature rose to 100 degree levels again, with 16,300 white blood cells per cu. mm. and 93 per cent polymorphonuclear cells on March 9. The diagnosis became one of an intra-abdominal collection of pancreatic fluid in the left upper quadrant; operation was consequently performed on March 10 with the objective of draining this collection. The operative findings were dramatic. In the nineteen days since the initial operation, a massive pseudocyst had formed in the pancreas about the size of a large, elongated orange. It was located in the body and tail of the pancreas, the long axis of this elliptical mass being in the longitudinal plane and to the left of the midline. Approximately 300 to 400 cc. of grayish fluid with mucoid material was aspirated from this cyst. Marsupialization of the cyst was performed through an opening in the gastrocolic omentum; a mushroom catheter was inserted into the cyst through this opening, and the edges of the opening sutured to the anterior abdominal wall. Examination of the fluid from this cyst revealed an amylase content of 569 units and a lipase content of 18 units. Culture of this fluid showed many Pseudomonas and some coliform organisms.

His postoperative course was generally satisfactory, with temperature returning to normal limits and remaining so until discharge from the Hospital on April 5. Sump drainage from the cyst reached a high point of 190 cc. on March 13 and decreased to zero on March 22. The stools were frequent, foul and slimy for about the first five days postoperatively. Starting on March 15, pancreatin tablets were given three times a day in 5 gr. doses, and his pancreatic cyst drainage was fed back to him, 30 cc. to a glass of coca cola twice a day. This was taken without any objection as to taste. The stool problem disappeared promptly coincident with this therapy. Examination of the stool was performed on March 8 to determine the presence of pancreatic enzymes, showing positive findings in the dilution of 1:5 and negative in dilutions 1:10, 1:25, 1:50 and 1:100. On March 14 stool examination was positive for trypsin digestion at 1:10 and 1:15 dilutions. The gastroenterologist placed the child on a heavy dosage of tincture of belladonna to decrease the pancreatic secretions; this dosage was increased to fourteen minims four times a day. The mushroom catheter was removed from the cyst on March 28 and wound healing progressed favorably. At the time of discharge from the Hospital there remained a pouting opening in the center of the incision with no appreciable drainage per day from it.

The weight increase and general betterment of this patient were impressive, his weight being 43 pounds on March 19, 1956, and 47 pounds on April 5. His attitude, alertness and over-all activity approached normal at the time of his discharge. He was seen again on October 1, 1956; he was feeling very well, looked as normal as any boy of his age and weighed 53 pounds. There was an incisional hernia present resulting from the marsupialization.

COMMENTS

In examining the recent literature on this subject, we find an excellent digest by Culotta, Howard and Jordan [2] of the reported material, pointing up several important facets. In

penetrating wounds of the pancreas, the prognosis is far worse than that in blunt injuries, which is due to the involvement of other vital organs in penetrating wounds. Thus in thirty-one cases of pancreatic injury, twenty-six were caused by penetrating instruments, twenty-one of which involved two or more organs, with a mortality of 16 per cent. The so-called blunt injuries, five in number, were not fatal. Complications in the pancreas, on the other hand, were much more frequent in the five cases of blunt injuries, three of them ending in pancreatic fistulas and two producing pancreatic cysts. This last finding is of interest, coinciding with the progress in the case reported herein.

The same authors cite the complications of blunt injuries to the pancreas from thirty-six cases collected from the English literature during 1945 to 1954, pseudocysts appearing in twelve patients (33 per cent), fistulas in thirteen (36 per cent), with three fatalities (8 per cent).

Kinnaird [*10*] in 1956 was able to collect from the English literature forty-seven such cases in the previous ten year period, adding five more from his own experience. To these may be added one reported by Newton and Nichol [*15*] in 1957 and the case herein reported, for a total of fifty-four.

Of interest is a new approach to the treatment of these blunt injuries resulting in rupture of the pancreas. The approach as advanced by Hannon and Sprafka [*8*] is direct and forthright. Primary resection of the ruptured or transected pancreas is involved, with removal of the distal portions together with the spleen. They present three cases in which this had been performed with uncomplicated recovery ensuing. Repeated blood sugar studies postoperatively showed no hypoglycemic tendencies.

CONCLUSIONS

1. A case of traumatic pancreatitis is presented.

2. Traumatic pancreatitis should be considered in all blunt abdominal injuries.

3. Serum amylase and lipase determinations should be performed in blunt abdominal injuries as important aids in the diagnosis.

4. The reported incidence to date and the prognosis of traumatic pancreatitis are discussed.

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Formation of Pseudoaneurysm

OCCURRENCE AFTER REMOVAL OF SYNTHETIC ARTERIAL PROSTHESIS

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THE SYNTHETIC vascular prosthesis has so many advantages that it obviously will continue to be used [1–5]. Occasionally, complications do develop because of severe reaction to a foreign body, particularly when infection is present. In some instances the graft must be removed. If this is done without re-exploring the vessel and closing it securely a pseudoaneurysm may result. The following is a report of such a case.

In the present case, it is presumed that a pulsating hematoma or pseudoaneurysm developed from the unligated end of the femoral artery.

CASE REPORT

A seventy year old white man was admitted to the emergency room. He had had many vascular grafts including bilateral replacement of femoral artery aneurysm with end-to-end nylon prosthesis. The most recent graft was the replacement of the left femoral artery from a point approximately 5 cm. below the inguinal ligament to the popliteal artery. It had been performed in the Ohio State University Hospital six months prior to this admission. The postoperative course was complicated by a wound infection and eventual extrusion of the synthetic prosthesis. The prosthesis was then entirely removed while the patient was on the ward.

Following this procedure the blood supply to the leg was maintained through the collateral circulation. The patient continued to do well. The wound healed slowly through third intention and the patient was discharged in good condition on the thirty-third hospital day.

Until the present admission the patient's progress had been good except that in recent weeks a pulsating mass had appeared in the left anterior thigh. This mass had increased in size. On the day of admission a small area of necrosis appeared on the skin overlying the mass; about 60 cc. of arterial blood was lost from this site.

Examination revealed a large pulsating inguinofemoral mass measuring approximately 15 by 15 by 9 cm. An area of recent clot formation was apparent on the overlying skin.

The patient was taken directly to the operating room. An inguinofemoral incision was made, exposing the common iliac artery extraperitoneally. This vessel was occluded with a Potts clamp. The pulsating hematoma was opened and the clot was removed. The open end of the femoral artery was seen at the level of the profunda femoris. There was brisk bleeding from the profunda. To close the common femoral artery securely, Matas type of endarterial closure of the profunda was carried out. This procedure was followed by double ligation of the common femoral artery. The wall of the false aneurysm was partially removed and a muscle flap from the sartorious muscle was used to partially close the defect. Postoperatively, the patient did well; the foot remained warm until the time of discharge.

COMMENTS

This patient presents an interesting history because of the etiology of the aneurysm and its probable origin through the failure to close the open end of the femoral artery when the nylon graft was removed. This false aneurysm presumably was formed by the constant pulsatile pressure against the organized thrombus at the open end of the femoral artery. The formation of a pseudoaneurysm in six months' time was the result.

With the increasing use of nylon and other synthetic prostheses, incidence of complications will certainly increase correspondingly. These complications include wound infections, the graft serving as a foreign body in the infected area. In such instances the graft itself may extrude or be debrided without re-exploration of the operative site, leaving an open-ended vessel occluded only by an organized thrombus. This

situation can be avoided by re-exploring and suturing the proximal arterial stump.

SUMMARY

A case is presented illustrating the formation of a pseudoaneurysm after the removal of an arterial graft which had become infected and thrombosed after surgery. An increased incidence of such a complication may be anticipated. The mechanism of the aneurysm formation is discussed and a method of avoiding the lesion is suggested.

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Artificial Pneumothorax

EFFICACY IN ENLARGING THE PERITONEAL CAVITY FOR EARLY SECONDARY CLOSURE OF CONGENITAL OMPHALOCELE

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THE efficacy of artificial pneumoperitoneum in enlarging the peritoneal cavity before repairing large hernias and eventrations in adults was reported by Moreno in Buenos Aires in 1947 [4], and subsequently by others in this country [2,3]. The usefulness of this method of preoperative preparation in adults having hernias with loss of the "right of domicile" has been confirmed by several years' experience at the Barnes Hospital. The present paper reports the use of artificial pneumoperitoneum in the preparation of a child for secondary closure of a congenital omphalocele, a purpose for which its use has not previously been reported.

CASE REPORT

M. B., (SLCH-19838), was normal at birth (July 11, 1958) except for the presence of eventration of the intestines and lower margin of the liver into a sac of peritoneum that was approximately 8 cm. in diameter. Six hours after birth cutaneous

FIG. 1. Lateral roentgenogram of abdomen and omphalocele taken with the child in the supine position.

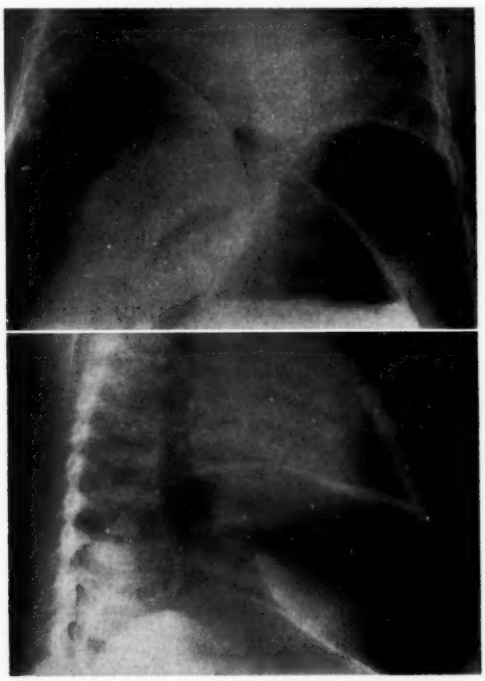

FIG. 2. Anteroposterior (*top*) and lateral (*bottom*) roentgenograms of the chest with the child erect.

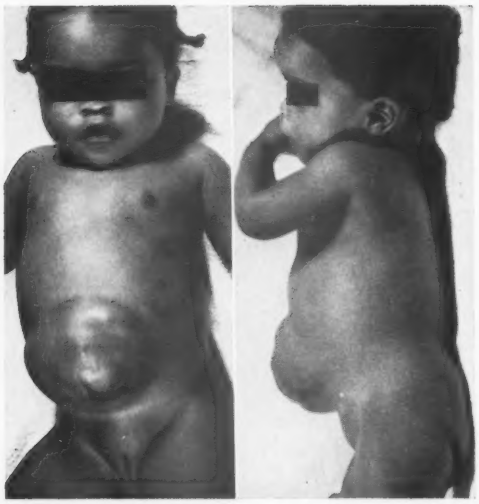

FIG. 3. The child with pneumoperitoneum at maximum volume.

coverage of the omphalocele was effected by the division of the skin at the base of the sac and bilateral subcutaneous elevation of the skin to the posterior axillary lines and lower costal margins. The edges of the skin were sutured over the sac with two layers of interrupted fine black silk. Subsequently, the child's growth and development were normal.

When the patient was ten and a half months of age the hernial contents could be reduced with some effort and the fascial margins of the eventration could be approximated manually but with a considerable degree of tension. An abdominal binder was used for nine days to determine whether the child could tolerate permanent reduction of the hernia. Reduction could not be maintained with the binder and the child was quite uncomfortable with it; therefore, its use was discontinued. On June 2, 1959, a pneumoperitoneum was effected by the introduction of 250 cc. of air

FIG. 5. Child on day of discharge from the hospital after repair of the omphalocele.

FIG. 4. *Top*, omphalocele just prior to incision. *Bottom*, collapsed hernial sac just after transverse incision. Note that the intestines remain within the peritoneal cavity.

through a short-beveled needle inserted at the lateral edge of the left rectus sheath. On June 3, 4, 5, 8 and 9, the procedure was repeated with the introduction of 250 cc. of air on each occasion. The abdominal cavity became progressively larger, but the most significant observation was that the hernial sac did not increase in size. This observation was confirmed by examination of the roentgenograms shown in Figures 1 and 2, taken on June 9. Figure 3 shows the child following the insufflation of air.

On June 10, eleven months after birth, operative repair of the fascial defect was performed. A nasogastric tube was passed before induction of anesthesia. A transverse incision was made through the skin. Figure 4 (top) demonstrates a lateral view of the sac immediately before the incision was made. As the air escaped from the peritoneal cavity and hernial sac through the incision, the hernial sac collapsed and lay in contact with the anterior rectus sheath and the midline fascial defect. (Fig. 4, bottom.) The intestines remained within the abdominal cavity after the incision was made and the pneumoperitoneum released. The fascial defect extended from the xiphoid to the symphysis pubis and its maximum width was 8 cm. A single-layer,

tensionless closure of the edges of the defect was easily effected with interrupted No. 3–0 black silk sutures passed through the cleaned fascial margins and the palpable edges of the rectus muscles. The postoperative course was uncomplicated. The child was discharged from the hospital on June 19, 1959 (Fig. 5), with the abdominal defect closed.

COMMENTS

The major requirement for the repair of massive abdominal hernias is the ability of the peritoneal cavity to receive the contents of the hernia without the introduction of respiratory insufficiency or vascular compression. Various methods of increasing the volume of the peritoneal cavity include the use of abdominal binders, artificial pneumoperitoneum [2–4] and phrenic crush [5]. Binders tend to produce a circumferential narrowing of the abdominal wall, and their use is complicated occasionally by pressure necrosis of intestines incompletely reduced from hernial sacs beneath the binders. Elevation of the diaphragm induced by phrenic crush can be achieved by pneumoperitoneum without paralyzing the diaphragm. (Fig. 2.)

Experience with pneumoperitoneum in the collapse therapy of pulmonary tuberculosis [1] established its safety provided that certain elementary precautions are observed. These precautions include: (1) use of the aseptic technic, (2) use of a short-beveled needle, (3) introduction of the needle into the peritoneal cavity at some point remote from scars, adhesions, hernias and immobile intra-abdominal viscera, (4) aspiration with the syringe before the air is introduced to make certain that the needle point is not in a blood vessel, and (5) maintenance of an intraperitoneal pressure less than venous pressure (plus 10 cm. H_2O). A water-filled spinal manometer fitted to a three-way stopcock between the injecting needle and syringe was used to record intraperitoneal pressure in this child. Since the intraperitoneal pressure recorded at the completion of an insufflation falls rapidly as the abdominal musculature relaxes to accommodate the increased volume, gross observation of the child's tolerance to the intraperitoneal air proved more important than absolute manometric readings. As the wall of the abdomen relaxed to accommodate the air, the hernial sac in this child remained of constant size and the application of restraints to the sac was unnecessary. The intraperitoneal volume of air was increased daily by small increments governed in volume by the tolerance of the child until the total volume of air within the peritoneal cavity exceeded the volume of the hernia. Roentgenographic examination (Fig. 1) proved to be the best method of confirming whether the peritoneal cavity contained a volume of air greater than the volume of the hernia.

The disparity between the size of congenital eventrations in children, as in the case presented herein, and the ability of the peritoneal cavity to accommodate the contents of the eventration is corrected incompletely by the growth of the child. As a child's rate of growth becomes slower, the rate of decrease in the disparity reaches a plateau, and the ratio of the volume of the eventration to the volume of the peritoneal cavity must approach a constant value since very large eventrations never close spontaneously. Ultimately, all large eventrations in children must be repaired. The use of artificial pneumoperitoneum to enlarge the peritoneal cavity permitted a safe fascial repair in the infant reported on herein.

CONCLUSION

An infant with a congenital omphalocele initially covered by cutaneous approximation is reported on in whom the use of artificial pneumoperitoneum to distend the peritoneal cavity permitted easy and early secondary closure of the associated fascial defect.

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Multiple Basal Cell Epitheliomas Arising in a Linear Nevus

REPORT OF A CASE

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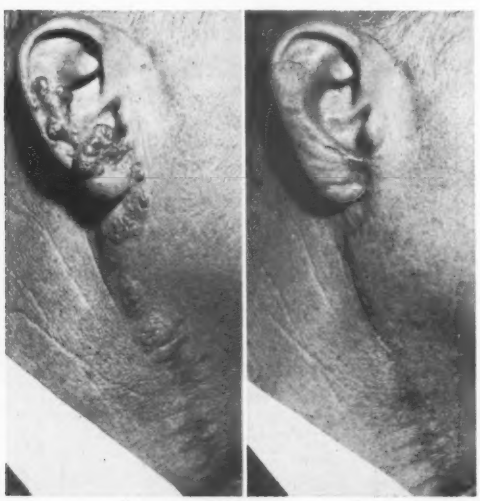
LINEAR nevus can be defined simply as "a nevoid growth which is arranged in fillets or streaks," [1] and it is not the intention of the authors to give a lengthy dissertation. Pack and Sunderland [2] in a comprehensive review preferred to designate the lesion as "naevus unius lateris." Their study includes four cases of their own and 156 from the literature.

Frequently, in Sutton's [1] experience, linear nevi arching over the ear have been the origin of basal cell epitheliomas. He recommended complete excision of the nevus in a single procedure, as the epithelioma recurs after piecemeal removal of the nevus.

Elsewhere in the literature only a limited number of reports of basal cell epithelioma arising in linear nevi were found. In Case 3 of Pack and Sunderland [2] four basal cell epitheliomas were removed from the right arm and right supraclavicular region of a thirty-six year old white man. Tôyama and Kojima [3] reported the case of a forty-seven year old woman with nevi distributed generally over the body. Multiple lesions on the abdomen were proved by microscopic examination to be basal cell epitheliomas.



A B

FIG. 1. A, extensive linear nevus of ear and neck. The uppermost three basal cell epitheliomas outline a triangle with the apex downward. The fourth epithelioma is adjacent to the antitragus. B, result after excision of nevus and epitheliomas of the ear and repair of defect with a postauricular skin flap. The nevus on the neck had been excised with primary closure.

REPORT OF A CASE

A fifty year old healthy white man, during the course of a general physical examination, requested surgical consultation for cosmetic improvement of a nevus on his ear and neck. The lower half of the nevus on his neck had been excised when he was about three years old. He had not received any treatment for it since, nor was he aware of any early or late changes in the remaining portion of the nevus.

Examination disclosed that the lesion was verrucous and extensive, covering most of the lower two thirds of the anterior surface of the right external ear. Scattered over the lesion were four raised, indurated, slightly translucent smaller lesions, each suggestive of basal cell epithelioma. (Fig. 1A.) The cervical portion of the nevus extended downward from the ear to join the scar from the excision mentioned.

Under local anesthesia the cervical portion of the nevus was excised and the wound closed primarily.

Histologic examination of tissue removed identified linear nevus. Biopsies were made of all four suspected basal cell epitheliomas of the ear, with report of basal cell epithelioma in each instance.

A plan was made for excision of the nevus and epitheliomas of the ear and staged reconstruction of the resulting defect. The initial stage consisted of adequate excision of the entire nevus to include the epitheliomas. The underlying cartilaginous framework was left undisturbed. Microscopic examination of fresh frozen sections indicated that excision of the epitheliomas was adequate at base and periphery. A large postauricular flap then was elevated and transferred to cover the defect on the ear. Three weeks later the pedicle of the flap was severed and a split-thickness skin graft applied to the donor site. A satisfactory cosmetic result was obtained. (Fig. 1B.)

SUMMARY AND CONCLUSION

The association of multiple basal cell epitheliomas with linear nevi was explored in the literature. In the case reported herein, treatment consisted of total excision of the nevus and epitheliomas. The uniqueness of multiple epitheliomas in a linear nevus seemed to be of sufficient interest to warrant reporting.

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Hemangioma of the Liver

REPORT OF A CASE SURGICALLY TREATED AND REVIEW OF THE LITERATURE

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HEMANGIOMAS of the liver are not infrequently found at autopsy. They usually appear as small reddish masses measuring about 3 to 10 mm. in diameter, situated just under the liver capsule, and presenting the typical spongy or cavernous histologic appearance [1]. These findings are purely incidental and no symptomatology is usually referable to them *in vivo*.

At times, however, some of these benign hemangiomas may attain larger size and then, mostly because of pressure, can become of surgical significance. Clinically, they often present a puzzling diagnostic problem since the symptoms which they cause can easily be related to various organs and diseases.

In a complete review on surgically treated hemangiomas of the liver, Shumacker states, "The symptoms which may be attributed to hemangiomas of the liver are not commonly known, the criteria upon which a preoperative diagnosis may be postulated are not fully understood, and the efficacy of the treatment not definitely appreciated" [2].

The validity of this statement is readily borne out by a review of the old and recent literature on the subject, as well as by the present case. This case summarizes well, we think, the common problems presented in diagnosing and treating such lesions.

CASE REPORT

This fifty-five year old married white woman was admitted to St. Elizabeth Hospital on May 14, 1959, complaining of dull intermittent pain in the left side of the chest of about three weeks duration. She had had five pregnancies and her menopause had occurred three years prior to admission. She had always been in good health and had never had any operations before. She did not drink any alcoholic beverages. There was no family history of tuberculosis, diabetes or neoplastic diseases. The dull, intermittent, nonradiating pain in the left side of the chest was localized in a general way over the left lower side of the chest from the sternum to the left anterior axillary line. It seemed unaffected by change of position, rest, food or deep breathing and was not accompanied by a sense of pressure or oppression, cough, fever or night sweats. There was no anorexia, nausea, vomiting, heartburn, belching or abdominal pain. Bowel movements were normal in consistency and number. On the day prior to admission, she consulted her physician about the chest pain. He felt a large mass in the right abdominal region and referred her to the hospital for investigation.

On admission, her temperature was 98°F., pulse 80 per minute and blood pressure 150/85 mm. Hg. She was a well developed, well nourished and rather short white woman. Systemic review was unremarkable. The heart showed normal sinus rhythm, was not enlarged to percussion and there were no murmurs. The abdomen was soft and revealed an oval, smooth mass, about 10 cm. in diameter, slightly tender and movable, located in the right upper abdominal quadrant and lumbar area. This mass was noted to move downward with inspiration. The liver could not be palpated along the right costal margin nor in the epigastrium. It was not certain whether the mass was connected with the liver. Auscultation of the mass was not carried out. Pelvic and rectal examinations were unremarkable.

Laboratory examinations showed a slight degree of anemia with 10.6 gm. of hemoglobin and an hematocrit of 37 per cent; white blood cells were

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5,800 with a normal differential. Urinalysis revealed nothing positive. Fasting blood sugar was 90 mg. per cent and the nonprotein nitrogen was 38 mg. per cent; bromosulphalein retention showed 5 per cent retention in thirty minutes, prothrombin time was thirteen seconds (control time was twelve seconds), cephalin flocculation was 1 plus in forty-eight hours and alkaline phosphatase was 0.8 units (normal 0 to 2.5). Urinary urobilinogen was positive in a 1:20 dilution. A Casoni test was not performed. On the day of surgery, hemoglobin was 11.9 gm., hematocrit was 39 per cent, and white blood cells were 5,000 with a normal differential. Results of urinalysis were normal. Electrocardiographic study revealed an essentially normal tracing. Radiologic examination, including chest, kidneys, ureters and bladder, intravenous pyelogram, barium enema, gastrointestinal series and cholecystogram did not reveal any abnormality nor displacement of any organs. A large mass was seen, however, in the right side of the abdomen extending from the liver to the pelvis. This was interpreted as probably due to an enlarged liver.

A diagnosis of hepatic tumor was made and an exploratory laparotomy was performed on May 22, 1959.

Surgery was performed under general endotracheal anesthesia. A long right muscle-splitting upper paramedian laparotomy was performed. In a series of about 400 cholecystectomies or common duct explorations, this incision has always been extremely satisfactory. On opening the abdomen, a large bluish mass, projecting from the undersurface of the right lobe of the liver, immediately came into view. This mass extended down toward the pelvis and was soft, movable and fairly easy to deliver. It was attached to the liver by a broad base measuring about 10 cm. in length and 5 cm. in width. A gross estimate of the size of the tumor was 15 by 10 by 6 cm. A diagnosis of hemangioma of the liver was self-evident. On further exploration of the liver surface, another hemangioma was found just to the right of the gallbladder. This was much smaller than the previous one, was sessile, and measured about 3 by 3 by 3 cm. in diameter. The remainder of the right lobe and the left lobe were grossly free of tumor. A favorable field was prepared by retracting the surrounding viscera with sterile packs. An incision was then made well into normal liver parenchyma just proximal to the implantation of the base of the tumor. This incision was carried out in an elliptical manner all around the tumor. This progressive incision allowed clamping of a large number of "feeding vessels" before their division, thus reducing the bleeding to a minimum. These "feeders" were then individually tied with No. 0 chromic catgut. The mass was removed and the remaining oozing from the raw surface of the liver was controlled by interrupted deeply

FIG. 1. Hemangioma sectioned through its base. Characteristic aspect of cavernoma.

placed mattress sutures of No. 0 chromic catgut which were tied over a double layer of Oxycel®. Immediately after excision, the tumor shrank to about two thirds of its previous size. The smaller hemangioma was then attended. This was more deeply located, bleeding was more profuse and could be controlled only by a deeply placed figure of eight sutures of No. 0 chromic catgut. When hemostasis was satisfactorily achieved, a stab wound was made in the right flank and a large Penrose drain introduced in Morison's pouch. Closure then was carried out in layers. Only 500 cc. ofblood were given during surgery.

The postoperative course was completely uneventful. Serosanguineous drainage was moderate for forty-eight hours and then rapidly decreased. The drain was removed on the seventh postoperative day. No bile was seen at any time in the drainage. The patient was discharged on the ninth postoperative day with no complaints. Her preoperative symptoms had disappeared completely and she has been free of symptoms for over one year.

PATHOLOGY

The specimens consisted of two previously bisected oval masses. They were soft and reddish blue and the larger one measured 13 by 10 by 5.5 cm. and weighed 260 gm. The smaller one measured 3 by 3 by 3 cm. and weighed 40 gms. (Fig. 1.) One portion of the surface was covered with grayish capsule which formed an apparent attachment that had been resected previously. Sections through the masses revealed partially lobulated tissue which was reddish brown and separated by thin grayish fibrous septa. The tissue revealed multiple punctate sievelike or cystic areas which freely exuded fluid blood from the cut surfaces. There was no gross evidence of liver substance on any

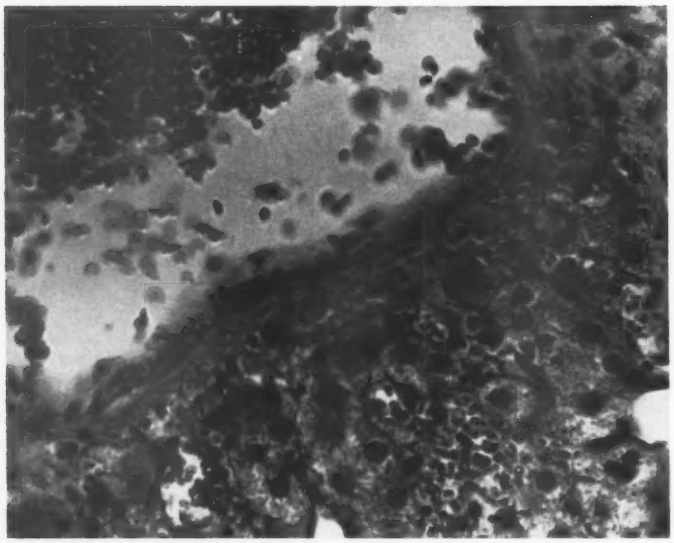

FIG. 2. Higher magnification of hemangioma showing the liver polygonal cells with adjacent cavernoma.

of the cut surfaces. Microscopically, sections showed segments of tumor tissue made up of large vascular spaces lined by a single layer of endothelial cells separated by closely packed fibroblasts to loose areolar and myxomatous tissue. Most of the blood vessels were of venous caliber. (Fig. 2.) In some of the larger trabeculae just below the capsule, there were segments of liver parenchyma made up of cords of regular hepatic cells and scattered small ductal and vascular elements. Wherever postal triads could be observed, the bile ducts showed no increase in cellularity or reduplication. The diagnosis was cavernous hemangioma of the liver.

COMMENTS

Hemangiomas of the liver are seen more commonly in middle-aged patients. Although not unheard of, they are rarely found in children [*30*], a fact which, for some investigators, would tend to demonstrate the neoplastic nature of these tumors. However, the present concept is that hemangiomas of the liver are of hamartomatous origin, fully recognizing that they may also arise in areas of localized necrosis and destruction of liver cells [*3*].

The incidence of hemangiomas in autopsy material varies between 0.35 and 7 per cent [*3–7*]. In none of the cases seen at autopsy by Feldman [*3*] was the tumor pedunculated, in contrast to the findings reported by Shumacker [*2*], who observed a pedicle in twenty-three of the sixty-two surgically treated hemangiomas. This is probably due to the small size of the hemangiomas found incidentally at post mortem. In about 10 per cent of the autopsied cases, the hemangiomas were multiple [*3*].

In nearly all the articles included in this review, there was a definite predominance of female patients. This could be related to pregnancy, as pointed out by Ninard [*33*].

Pfannenstiel [*8*] resected the first hemangioma of the liver in 1898. Since then, many reports have appeared both in the foreign and American literature [*9–21*].

The problems encountered when attempting to diagnose these tumors prior to surgery, in interpreting the variety of symptoms which could or could not be related to their presence and in meeting the challenge of their surgical removal, make hemangiomas of the liver an interesting entity.

Although it is commonly accepted that the presence of a mass is the most common symptom, this does not seem to have helped much in the diagnosis. Of the sixty-two cases reviewed by Shumacker [*2*], only two were diagnosed correctly before surgery.

Wilson and Tyson [*22*], in 1952, also men-

tioned the difficulty in making a correct diagnosis. Henson and associates [23], in reviewing thirty-five cases of hemangiomas found at the Mayo Clinic between 1907 and 1954, stated that in none of them was a correct diagnosis made preoperatively. In our case, a diagnosis of hemangiomas was not made or even suggested prior to surgery, although a tumor of the liver was suspected.

Considerable aid in obtaining a preoperative diagnosis could come from more complicated means like gammagraphy and laparoscopy with or without color laparophotography. The value of these technics has been well illustrated by Caroli and his group in France [24].

If a diagnosis cannot be made, the mere presence of an abdominal mass imposes the duty of performing an exploratory laparotomy. At this time the typical appearance of the tumor with its connection to the liver should be sufficient to permit the proper diagnosis.

Usually, large hemangiomas of the liver are solitary, but, as in our patient, they may be multiple. If a small hemangioma is overlooked at the time of surgery, it could probably grow to a larger size and necessitate reoperation at a later date. This possibility should always be kept in mind and all the surfaces of the liver should be inspected carefully during surgery. At times, all of the liver may be involved by hemangiomas; after possible removal of the larger ones which could rupture, one should resort to roentgenotherapy. Satisfactory results with roentgenotherapy have been reported, particularly when treatment was begun early in the disease. This is well documented by the works of Morris [25], Ray [26] and, more recently, Levitt and associates [27].

Sporadic good results obtained with roentgenotherapy for diffuse or inoperable hemangiomas of the liver do not relegate surgery to a secondary role. On the contrary, the great danger of rupture, with its mortality of almost 100 per cent, suggests the necessity for an early and radical extirpation of these vascular tumors. The statistics reported by D'Errico of twelve deaths out of fourteen instances in which hemangiomas ruptured is significant [28]. Improved surgical technics and the ready availability of blood now make this operation much easier than in the past, provided one uses the fundamental principle, enunciated by Horsley [29] in 1928, of always incising into normal liver tissue around the hemangioma, but not into the hemangioma. Shumacker [2] and Wilson [22], among others, gave detailed descriptions of the different technics that can be used in excising these tumors and in controlling hemorrhage.

The technic, used on our patient, to separately clamp all the feeding vessels connecting the hemangioma to the liver has seemed entirely satisfactory. If a prominent venous connection to the liver is usually found, one should not forget that at times a large arterial supply is present and that temporary clamping of the homolateral hepatic artery, as suggested by Caroli and his group [24], can be considerably helpful.

Surgical mortality has been very low when the operations are performed by experienced hands. In Shumacker's report [2], only one patient died following surgery, as compared with five deaths out of eleven patients in which the tumor had not been resected at surgery. If the surgeon believes the tumor is unresectable, no attempt should be made to perform a partial resection with packing or even a biopsy, because serious and sometimes fatal bleeding may occur. It would be much better, in such instances, to close the abdomen without further manipulation of the tumor. Thereafter, a course of radiotherapy, started as soon as possible, would be indicated. Surgery should also be discarded if blood is not readily available.

However, it would seem that by adhering to the principles enunciated by Shumacker and by following the technics of hepatectomy that Lortat-Jacob [31] in France and Pack [32] in this country have recently demonstrated, one should be able to carry out a complete excision in most instances of solitary benign hemangiomas of the liver.

SUMMARY

A case of double hemangioma of the right lobe of the liver, treated surgically, is presented. The technics for diagnosing and resecting such vascular tumors are reviewed. The need for a wide excision and for placing all incisions in the normal adjacent liver parenchyma and the dangers of partial excision and of biopsy are re-emphasized. The value of roentgenotherapy in diffuse or inoperable hemangiomas is acknowledged.

Acknowledgment: We are indebted to Dr. Joseph W. Tandatnick of the Department of

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Stab Wounds of the Heart

TWO UNUSUAL CASES IN MANAGEMENT

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THE penetrating knife wound of the heart remains a fascinating problem. In a large experience of well over 150 cases [1,2] the vast majority amenable to therapy have projected a classic clinical pattern characterized by initial shock and evidence of the development of an intrapericardial pressure due to hemopericardium, a phenomenon known as pericardial tamponade. Diagnosis was relatively simple and made with a high degree of certitude and accuracy.

From time to time, however, there have been departures from the classic pattern, inherent in the unpredictable behavior of the mechanism of pericardial tamponade in association with the wounds of both myocardium and pericardium. These aberrant patterns have contributed significantly to our knowledge in this field and it is with this in mind that we wish to present two interesting cases of recent vintage.

In Case 1 the attending surgeon decided that, in view of the patient's excellent condition, surgical observation was in order. This decision was based on a careful evaluation of the patient's physical status. The pulse was within normal range (84) and of good quality. The venous pressure, which was initially 300 mm., fell to 190 mm. Hg within two hours. The blood pressure was stabilized with only three units of plasma. The patient was therefore in no immediate danger and a longer period of observation could be entertained.

CASE REPORTS

CASE 1. A thirty year old man (No. 59-1058) was admitted to Harlem Hospital on July 11, 1959, with a stab wound of the chest wall in the second left intercostal space near the sternal border. The assault occurred approximately twenty minutes prior to his admission.

Past History. The patient had been hospitalized for pneumonia in 1947, for abdominal exploration in Chicago in 1952 because of a stab wound of the abdomen, for operation because of intestinal obstruction in 1953 and for lye burns of the face in 1954. His occupational history revealed that from 1943 to 1951 he worked as a prize fighter and since that time has been employed as a construction laborer and bricklayer. The patient also reported a history of large alcoholic intake and heavy smoking. During the previous three to four years he had had dizzy spells accompanied by tachycardia and blurring of vision.

On admission the patient was conscious and oriented, with a blood pressure of 70/50 mm. Hg and pulse rate of 84. A 1 cm. stab wound located in the second interspace at the left parasternal line was noted. Heart sounds were distant but regular. The lungs were clear and the abdomen soft with two old incisional scars. The initial venous pressure was 300 mm. of H_2O.

The intravenous administration of plasma was started immediately and roentgenograms were taken. In an anteroposterior film of the chest the pericardial silhouette was enlarged, with straightening of the left cardiac border (Fig. 1), a finding that has been almost pathognomonic of hemopericardium in traumatic cases that we have observed. A repeat reading of venous pressure two hours after administration was 190 mm. H_2O; blood pressure was then 88/60 mm. Hg and pulse 76. By this time the patient had had three units of plasma and there was no longer any evidence of respiratory embarrassment. Approximately nine hours after admission the blood pressure rose to 130/90 mm. Hg and repeat venous pressure registered at 190 mm. H_2O.

An apical systolic murmur was heard on examination of the heart. An electrocardiogram showed only a sinus bradycardia. On July 14, the third day after admission, the blood pressure continued stable, venous pressure dropped to 180 mm. H_2O, heart sounds became louder and the systolic murmur diminished in intensity. An x-ray film of the

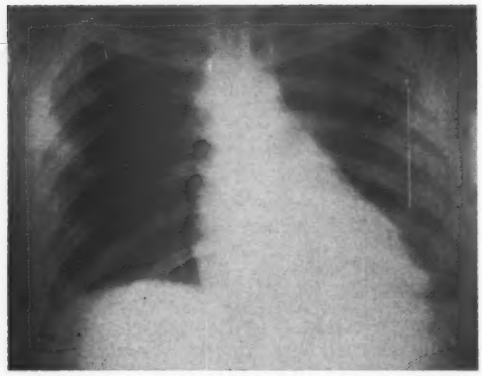

FIG. 1. Case 1. Original film showing enlarged pericardial silhouette with straightening of the left cardiac border.

chest on the fourth day showed regression in the size of the pericardial silhouette.

On the sixth day following admission the venous pressure droppped to 140 mm. H_2O; the vital signs continued to be stable; the apical murmur disappeared and the lungs were clear. His condition was so satisfactory that the patient was permitted out of bed. The electrocardiogram at that time showed a sinus bradycardia and was interpreted as being compatible with acute anterolateral wall injury. (Fig. 2.)

Observation of the patient continued. The blood pressure remained around 120/70 mm. Hg; venous pressure continued between 120 and 140 mm. H_2O; cardiac sounds returned to normal intensity and the cardiac silhouette reverted to more normal appearance in both side and shape. The patient remained in the hospital for a total of thirteen days and was discharged in good clinical condition.

Ordinarily the stab wound of the heart presents a clear-cut picture with shock, evidence of blood loss and/or pericardial tamponade, usually the latter. Roentgenographic findings are usually characteristic of this pathologic condition (pericardial tamponade), especially with regard to the enlarged pericardial silhouette and the straightening of the left border of the heart shadow. This characteristic straight line is usually present, even in those patients who are apparently in good condition, with reasonably good blood pressure and palpable pulse, and may remain so during a prolonged period of stabilization. There is rarely any

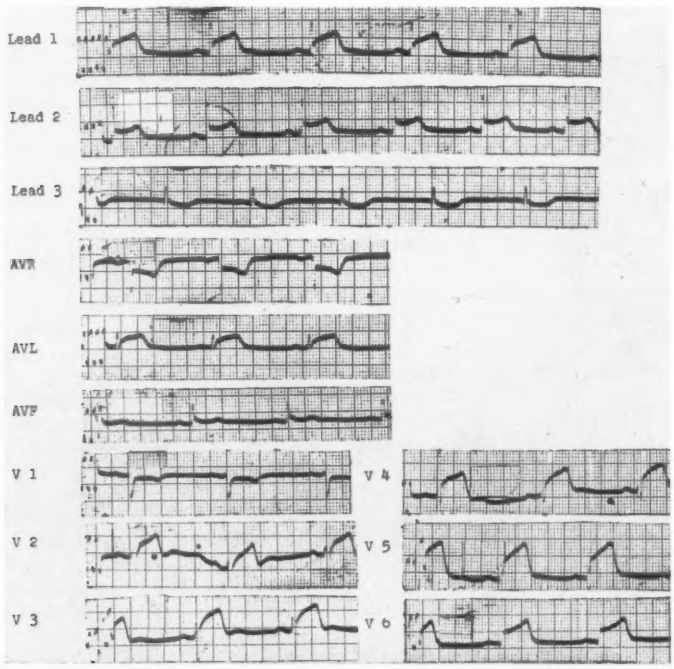

FIG. 2. Case 1. Electrocardiogram. Interpretation: Recent anterior wall myocardial damage as evidenced by S-T elevation at leads I, II, AVL and V_2 to V_6; reciprocal changes at lead III and AVR.

TABLE 1
VITAL INDICES SHOWING PROGRESSIVE SPONTANEOUS STABILIZATION OF PATIENT (CASE 1)

Date	Blood Pressure (mm. Hg)	Venous Pressure (mm. H_2O)	Pulse Rate (per min.)
7/11/59 (Admission)	70/50	300	84
7/12/59 (1:30 A.M.)	88/60	190	76
7/12/59	104/70	...	60
7/13/59	130/90	190	78
7/14/59	130/80	180	76
7/15/59	130/78	...	68
7/16/59	120/80	...	...
7/17/59	130/68	140	64
7/18/59	94/60	134	70
7/19/59	118/60	120	62
7/20/59	140/60	150	...
7/21/59	110/60	120	60
7/22/59	110/70	...	...
7/23/59	120/64	150	72

acute and dramatic variation in these x-ray findings, even when the heart wound obturates spontaneously or as a result of pericardial aspiration.

It is therefore most unusual to encounter a case in which the patient had initially an enlarged pericardial silhouette which increased over a period of about ten hours and then subsequently returned to normal both in size and outline in seven days, and with this, an apparent complete stabilization of the patient. (Table 1.)

At the time of discharge (July 24, 1959) the patient, from a functional cardiac standpoint, was clinically normal although his electrocardiogram indicated cardiac damage.

Our increasing experience in the management of stab wounds of the heart suggests that obturation of a cardiac wound, with spontaneous healing, may be more frequent than had been previously supposed.

In this instance, the case was one of traumatic hemopericardium without any doubt, and we believe that we were quite correct in our assumption, affirmed by the electrocardiographic findings [3], that there was also myocardial injury which accounted for the hemopericardium. The rapid and dramatic return of the pericardial silhouette to normal certainly indicated a very effective and almost complete spontaneous decompression of the hemopericardium.

It is hoped that this documentation will serve to spur observations for this type of case and that recognition of such cases will be verified by other surgeons. Again, this case demonstrates that there is no simple answer for the problem of the heart wound except through appreciation of the great variations in the behavior pattern of pericardial tamponade incident to hemopericardium, which is inherently a dynamic and not a static mechanism.

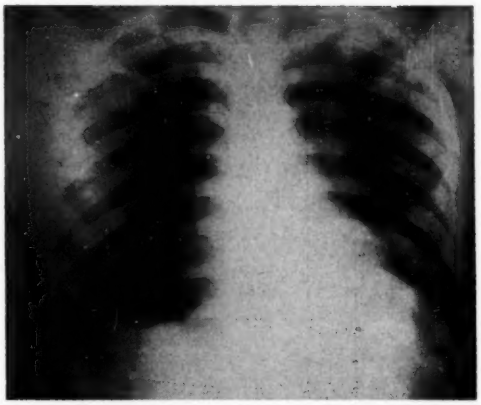

FIG. 3. Case II. Admission film showing enlarged pericardial silhouette with straightening of the left cardiac border.

CASE II. This twenty-two year old patient (No. 58-18161) was brought to the Harlem Hospital emergency unit on December 27, 1958, approximately twenty minutes after being stabbed with a knife in the left chest. The patient, a well developed and well nourished man, was in shock. There were three stab wounds in the left hemithorax. The first one was located in the third intercostal space at the anterior axillary line, the second at the lateral border of the scapula at the level of the third intercostal space and the third in the sixth intercostal space midway between the mammary and the anterior axillary lines, the last with surrounding subcutaneous emphysema. The heart sounds were muffled and distant. However, both lung fields were clear to auscultation and percussion. The neck veins were markedly distended. The venous pressure was 300 mm. H_2O. Blood pressure was 60/40 mm. Hg, indicating a narrow pulse pressure; respiration rate 28; pulse rate 120 and weak. The admission x-ray film (six feet, upright) demonstrated an enlarged pericardial silhouette and no evidence of hemopneumothorax. (Fig. 3.)

The clinical impression was stab wound of the heart, associated with hemopericardium. The shock state was promptly treated with plasma and blood.

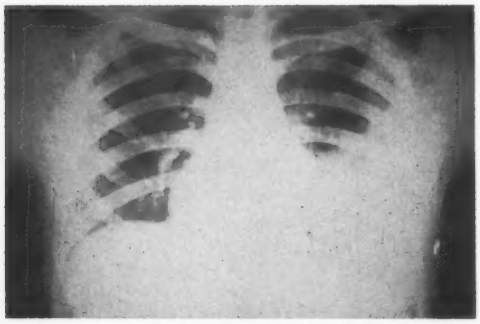

FIG. 4. Case II. Roentgenogram on the ninth day showing lack of regression of hemopericardium and hemothorax.

Unfortunately, the patient refused to have a pericardicentesis and/or surgical exploration. He was closely observed and received intravenous fluids and oxygen as supportive measures. A second chest film taken six hours after admission showed a decreased cardiac silhouette and some cloudiness appeared at the base of the left hemithorax. At the time the venous pressure dropped to 180 mm. H_2O. The heart sounds were strong and the blood pressure 120/80 mm. Hg.

A twelve hour chest film indicated extension of the opacity in the left chest, suggesting a progressing left hemothorax. A thoracentesis performed at that time yielded 50 cc. of dark thick blood. The patient's condition was slightly improved.

During the first week of hospitalization he complained of shortness of breath and sharp retrosternal pain on deep inspiration. A low grade fever persisted. Roentgenograms of the chest taken daily showed no regression of the hemopericardium and hemothorax. (Fig. 4.) On the tenth hospital day, the Director of Surgery reviewed the chest films and, considering the patient's clinical course and the possibility of an acute catastrophe, recommended immediate surgery. The patient still refused operation and remained in a precarious state.

Because of continuous bouts of hypotension and tachycardia, there was increased conviction that a blowout of the obturation of the ventricular wound might be imminent. The patient finally consented to surgery and on the eighteenth hospital day, a left thoracotomy was performed. A two inch healed laceration of the left portion of the pericardium was found, with the left lung firmly adherent at the site. On opening the pericardium 100 cc. of blood gushed from the pericardial sac. Then an unhealed myocardial laceration, 2 cm. in length, was observed at the base of the left ventricle, midway between and parallel to the anterior descending and circumflex branches of the left coronary artery. The edges of the myocardial wound were gaping and bleeding, and the wound itself spurted droplike amounts of blood with each ventricular contraction. There was also a sanguineous weeping from the edges of the myocardial wound. No attempt was made to remove the incompletely organized clot that obturated the wound, but instead the wound was closed with four interrupted sutures of No. 000 atraumatic silk, satisfactorily coapting the myocardial edges. The pericardium was left widely open.

The patient's postoperative course was uneventful. He was ambulatory on the second postoperative day and was fully recovered approximately one month after admission.

COMMENTS

At this hospital we have preferred the direct surgical approach to stab wounds of the heart. Aspiration in our hands has been used only as a temporary expedient while awaiting surgery. Aspiration in itself is hazardous and not infrequently unsuccessful because the blood in the pericardium is clotted.

These two cases have been presented as variations from the classic clinical pattern of the penetrating wound of the heart. Although, in the first case, hemopericardium was not verified by the aspiration of blood, there is little question but that the enlarged pericardial silhouette was indicative of blood in the pericardial sac. The spontaneous decompression, with return of the pericardial sac to normalcy in seven days, is a dramatic manifestation that we had not previously encountered. If it can occur spontaneously, it is logical to assume that it can occur with pericardial aspiration [*4–6*]. It undoubtedly does, of course, in some cases and, although we do not prefer it as definitive treatment, it cannot be denied that selectively it may be effective [*7*]. It must be remembered that the final outcome is always determined by the interplay of three factors: (1) the myocardial wound; (2) the pericardial wound and (3) the hemopericardium.

At the wound sites the determinants are: (1) continued bleeding and (2) cessation of bleeding (obturation); and later, (1) organization of clot and (2) infection.

In the case of hemopericardium the outcome depends on the maintenance of an innocuous, sublethal pressure by (1) spontaneous decompression and/or (2) cessation of bleeding into the pericardium.

The patient in Case II had spontaneous, although fluctuant stabilization, over a period

of ten days. There was evidence, considering the time factor, of delay in organization of the obturating clot at the myocardial wound site. With the patient's continued uneven course, it was clear that if by eighteen days stabilization was not constant, the obturation was precarious, probably because of low grade infection and perhaps mechanical factors. A blowout was possible and this could be calamitous. At this stage surgery was indicated, in fact, mandatory. Intervention proved this point.

The mechanism that creates pericardial tamponade accounts for the variation in clinical behavior in the penetrating wound of the heart. The unpredictables in this situation help to implement our conviction that surgical intervention, with the proper surgical setup and in competent hands, is the answer to the problem of the penetrating wound of the heart.

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The Incompetent Sphincter of Oddi

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THE papilla of Vater has been considered recently in the medical literature as the underlying factor in many cases of pancreatic and biliary tract disease. Its anatomy and physiology have been investigated thoroughly and its variations along with the variations of the adjacent biliary and pancreatic ducts well documented [7]. Many of these disease processes have been attributed to spasm or stenosis of the sphincter of Oddi, and direct attacks on this organ have been advocated in some instances to produce a relative incompetence of the sphincter. However, the gross incompetence of a surgically inviolate sphincter of Oddi has been only occasionally suggested and rarely demonstrated.

The demonstration of barium in the biliary tree during roentgenographic examination of the upper intestinal tract is ordinarily considered diagnostic of a fistulous communication between the intestinal and biliary tracts. Hicken and Coray [5] and others [3,6] state that reflux of air into the biliary tract occurs so rarely that its presence confirms the diagnosis of a biliary-intestinal fistula. This was certainly our opinion on viewing the roentgenograms of the patient in the first case to be reported. In the second case our previous experience indicated the proper diagnosis. Three cases [9,11] have been found in the literature which showed the presence of both gas and barium in the biliary ducts in the absence of a fistula.

CASE REPORTS

CASE 1. Mrs. K. S. was first seen by us in 1950, at the age of sixty-five years, with chronic abdominal distress, consisting of episodes of indigestion, constipation and rather constant flatulence and abdominal distention. A rather complete examination at that time was essentially within normal limits. There were no abnormal physical findings in the abdomen; routine blood tests, liver function tests and stool examinations were within normal limits. Her general health and appearance were good, past history was not significant and her physical status well preserved.

At that time roentgenographic examination of the gallbladder, stomach and duodenum, and colon with contrast media revealed no abnormalities, and the observed function of the various organs was normal. Treatment at that time was symptomatic, as it has been since, with dietary restriction and many varied medications. However, flatulence and eructation continued with occasional episodes of abdominal pain and more severe indigestion.

Further roentgenograms were taken in 1952, 1954 and 1956. The upper intestinal tract and colon remained normal. However, roentgenograms of the gallbladder showed poor function in 1952 and shadows consistent with biliary calculi in 1954 and 1956. Operative intervention was advised but declined.

On December 29, 1956, the patient was admitted to Harris Hospital with an attack of acute upper abdominal pain, associated with tenderness in the right upper quadrant. This was clinically typical of acute cholecystitis. The pain radiated through to the right scapular region and was associated with nausea and vomiting. No mass was palpable. The symptoms and findings subsided spontaneously and she was discharged on January 4, 1957. Laboratory tests at this time were of no significance except for an elevated white blood count compatible with acute inflammation.

The previous chronic symptoms continued and treatment with diet, belladonna alkaloids and other antispasmodics was not too effective. On June 5, 1957, an upper gastrointestinal series was performed and filling of the biliary tree with barium was demonstrated. (Figs. 1 and 2.) Calculi were thought to be present in the common duct. A complete physical examination at this time was entirely within normal limits, except for the abdomen, where there was minimal tenderness deep in the right upper quadrant. Tests of liver function were entirely normal. The patient was readmitted to Harris Hospital on June 18, 1957 (Case No. 12093), where laboratory findings and general

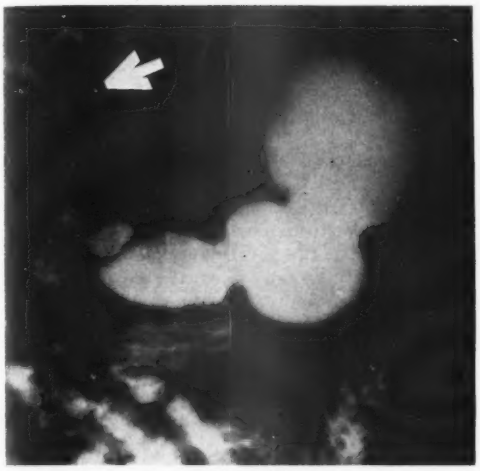

FIG. 1. June 5, 1957. Barium filling common duct and hepatic ducts during upper intestinal roentgenographic examination. Shadows originally thought to be stones in the duct are probably due to air.

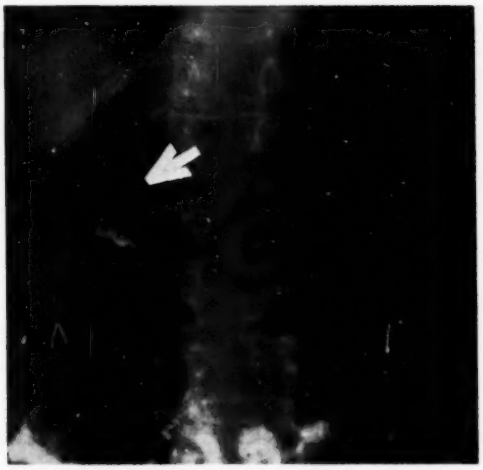

FIG. 2. June 5, 1957. Four hour film showing biliary ducts outlined with air, majority of barium having escaped.

physical examination were again entirely normal. Surgical exploration of the right upper quadrant was performed with the patient under general anesthesia on June 20. Abnormal findings were limited to the biliary tract. The gallbladder was thick-walled and chronically diseased. The cystic and common ducts were dilated and had comparatively thick walls. No evidence of a fistula was present. Thorough exploration of the common duct revealed no stones and no fistula. A cholangiogram taken through a T-tube at operation likewise showed no evidence of fistula but normal termination of the common duct was seen in the duodenum. (Fig. 3.) The gallbladder was removed and the T-tube left in the common duct; a Penrose drain was led down to the gallbladder bed and the incision was closed. Her postoperative convalescence was entirely satisfactory. She was discharged from the hospital on July 5, 1957, and the T-tube was removed ten days later. Pathologic examination of the gallbladder confirmed the diagnosis of chronic cholecystitis. No stones were present in the gallbladder. We regret to state that the patient's flatulence and eructation have continued. However, she has had no further episodes of acute abdominal pain.

Comments: When the earlier roentgenograms of the biliary tract were reviewed in the light of the operative findings, it was thought likely that the "stones" in the common duct probably represented air bubbles. When the roentgenograms from the previous years were examined, air in the biliary system could be seen. (Fig. 4.) An upper gastrointestinal series performed in April of 1958, ten months following surgery, showed no reflux of barium through the sphincter of Oddi, but in October of 1958, such a reflux was again demonstrated.

FIG. 3. June 20, 1957. Cholangiogram through T-tube at time of surgery. Normal termination of common duct is demonstrated.

FIG. 4. July, 1956. Oral cholecystogram. Dye-filled gallbladder containing two small stones. Shadow of air filled common duct.

Chronic disease of the gallbladder was present in this patient, and it is considered probable that stones had been present in the gallbladder and ducts in the past. Her acute illness six months prior to surgery may well have been caused by passage of a stone through the ducts into the duodenum. This may have happened more than once. The absence of acute abdominal episodes since surgery adds credence to this supposition. The passage of a stone through the ampulla could have caused this dilatation and demonstrated incompetence.

CASE II. Mr. H. V. M. was seen for the first time in Harris Hospital on May 2, 1960 (Case No. 60–7473), complaining of severe pain in the lower part of the chest and the epigastrium of several hours' duration. He had become increasingly weak and had had generalized malaise for several days prior to this, and at the time of onset of the pain he had become quite faint. He had come to the emergency room, where he showed rather severe distress and was complaining of pain in the chest and weakness.

The patient had been admitted to numerous hospitals, both to Harris Hospital and other local hospitals, in the past fifteen years. In 1929 he was hospitalized elsewhere for an abscess of the liver. No records have been obtained concerning this illness. In 1943 he was hospitalized because of upper abdominal distress and indigestion with pain radiating through to the back. At this time cholecystograms and intravenous pyelograms showed no abnormalities. Because of continued epigastric distress he was hospitalized in 1950, and cholecystectomy performed. No mention of exploration of the common duct was made at that time. The pathologic report was chronic cholecystitis. No stones were present in the gallbladder. Appendectomy was performed for acute inflammation in 1954. In 1955 he was hospitalized (All Saints Hospital) because of epigastric distress accompanied by nausea and vomiting. This was not an acute illness, however, and an upper gastrointestinal series showed a severe deformity of the first portion of the duodenum and an ulcer. Because of his continued distress, operation was performed. Numerous dense adhesions were found in the right upper quadrant around the duodenum, common duct and gallbladder bed, probably due to the previous surgery. The common duct was of normal size but appeared kinked by some adhesions. No evidence of stones or tumor was found. There was also marked edema and inflammatory reaction around the duodenum, pancreas and pyloric region of the stomach. Vagotomy and gastrojejunostomy were performed. He recovered from this operation, but continued to have epigastric pain and also began to have gastrointestinal bleeding. Because of this, he was admitted to Harris Hospital several times in 1955 and 1956. Gastrointestinal series demonstrated gastric retention and marginal ulcer on various occasions, but there was no evidence of air or barium in the biliary tract. In 1957 the patient was hospitalized for a similar episode and a gastrointestinal series showed these same findings. Gastric resection with gastrojejunostomy was performed. At this time no further exploration of the common duct was performed. The patient has since been on an ulcer diet and medical therapy.

Physical examination showed a rather emaciated elderly white man in moderately severe distress. The examination essentially revealed no abnormalities except for pallor and the abdominal findings. Here, upper right and left rectus scars and a scar in the right lower quadrant were noted. There was slight distention, no palpable masses were present, and no organs were palpable. There was moderate tenderness in the epigastrium. Rectal examination revealed four plus guaiac on examination of the stool. On admission hemoglobin was 4.4 gm. per cent with 2,150,000 red blood cells per cu. mm., 9,600 white blood cells per cu. mm., with a differential of 86 per cent neutrophils, 11 per cent lymphocytes and 3 per cent monocytes. The smear showed marked anisocytosis with hypochromia. He received 4 pints of blood with elevation of the hemoglobin to 10.7 gm. per cent. Over the next twenty-four hours his abdominal distress increased,

FIG. 5. May 3, 1956. First film of upper gastrointestinal series showing air in biliary tract.

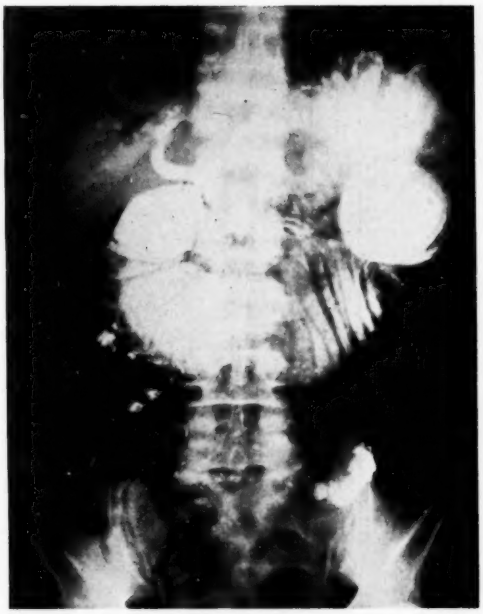

FIG. 6. One hour film. Distention of duodenum with barium filling common duct.

he became distended and began having nausea and vomiting. Examination of the abdomen revealed distended intestinal loops in the upper portion with visible peristaltic waves. With a diagnosis of partial intestinal obstruction, an upper gastrointestinal series was performed on May 3. This examination showed probable obstruction at the gastrojejunostomy with dilatation of the duodenum. It was at this time that air was found in the common duct (Figs. 5 and 6) with barium regurgitation into the common duct. The latter was thought to be an incidental finding, and the patient was put on a conservative regimen for the treatment of intestinal obstruction with a nasogastric tube connected to suction and intravenous feedings. Over the next four days the patient's condition improved considerably; the gastric distention and discomfort disappeared. The nasogastric tube was removed and liquid feedings, followed by a soft diet, were begun. He tolerated these well with no further evidence of intestinal obstruction and was discharged from the hospital on May 13, 1960.

Comments: This patient's difficulties largely stemmed from peptic ulceration, and the presence of air in the common duct and regurgitation of barium was considered an incidental finding. As this showed up in none of the numerous previous gastrointestinal series, the presence of an intestinal obstruction with considerable dilatation and increase in the intraluminal pressure of the duodenum is thought the predisposing cause. It is doubted that gallstones have ever played a part in this process because none have ever been demonstrated and examination of the common duct at two operations has shown no abnormality other than a slight kinking of the duct.

OBSERVATIONS

Scott et al. [9] have reported ten cases of barium or air filling the biliary tree at the time of upper abdominal roentgenograms. Six of these patients were shown to have reflux through the papilla of Vater, while four had biliary-duodenal fistulas. This ratio does not usually exist as is shown in the remainder of their article. In their extensive review of the literature, they collected 156 cases of fistula involving the biliary tract and only nineteen cases of reflux into the duct. Thus, counting their own cases, approximately 14 per cent of cases showing barium or air in the biliary tree was due to reflux through the papilla. This figure is interesting since in 1890, Courvoisier [2], in a study of common duct stones, showed the ampulla of Vater to be dilated in 14 per cent.

FIG. 7. Six hour film. No further barium seen in biliary tract.

Williams and Busch [12] in 1907, showed experimentally that incompetence of the sphincter of Oddi can be produced by the passage of a gallstone. It was only in 1921, however, that Beall and Jagoda [1] and Stephenson [10] demonstrated regurgitation of barium through the sphincter of Oddi clinically. Scott et al. [9] were of the opinion that in four of their six patients, the passage of one or more stones through the ampulla was responsible for the incompetence. Poppel [8] lists a number of other possible causes of gas or barium in the biliary tract, including adhesions and tumors deforming the ampulla of Vater, disturbance in innervation and biliary tract infection. Gas in the biliary tract in cases of intestinal obstruction due to impacted gallstone has been reported [9]. That reflux is not demonstrated more often can be attributed to several factors. The diagonal course of the common duct through the duodenal wall and the consequent constrictive actions of the duodenal musculature are probably as important as the sphincter of Oddi and the termination of the duct on the papilla.

The cause of the incompetence in the first case is not known. It was probably due to repeated passage of stones through the sphincter or a disturbance of innervation. That it was not transitory is evident by its repeated demonstration. In the second case, it was almost surely due to the partial intestinal obstruction with the resulting increased intraluminal pressure.

Since Scott's review in 1954, no other cases have been reported. However, Walters, in a discussion of a paper by Epperson [4], mentioned two other cases of reflux occurring at the Mayo Clinic.

A point in differentiating biliary-duodenal fistula from reflux at the time of fluroscopy is offered by Hicken and Coray [5]. In instances of fistula, "progress films invariably reveal the barium to be incarcerated in the common bile duct six to twelve hours after the ingested barium has passed from the duodenum into the lower intestinal tract." Whereas, in reflux through an atonic sphincter, "the barium . . . does not remain in the common duct, but readily escapes through the gaping sphincter of Oddi and goes along with the main barium meal . . . " Demonstration of this can be seen in both of these patients. (Figs. 1, 2, 6, and 7.) The significance of this finding in the first case was not appreciated by us prior to operation. It is of importance since surgical correction of an incompetent sphincter is not necessary. Ascending infection as a complication is not apt to occur since escape of any refluxed intestinal content occurs readily. On the other hand, retention of contents in the biliary tract occurs when a fistula is present; infection is likely and surgical repair is usually advisable.

SUMMARY

While the demonstration of air or barium in the biliary tract is usually due to fistulous communication with the intestinal tract, the possibility of an incompetent sphincter of Oddi with reflux should be considered, and a point in differentiating this reflux from fistula is reemphasized. Two cases in point are presented.

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CASE ANALYSIS CLINIC

Esophageal Obstruction

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A TWENTY-NINE year old Negro woman developed bandlike deep aching back pain at the level of the ninth thoracic vertebra, left shoulder pain and substernal discomfort eight months prior to admission. Pain was aggravated by eating and not relieved by medications, heat, massage or adhesive strapping of the chest. Dysphagia occurred with solid foods and two months prior to admission she could retain only liquids. Regurgitation of liquids and persistent vomiting started two weeks before hospitalization. The development of a productive cough and twenty-four pound weight loss in one month suggested pulmonary tuberculosis and she was transferred from a state reformatory to the Ohio Tuberculosis Hospital for diagnosis and treatment.

Historically, the patient admitted drinking six to eight quarts of wine or a bottle of whisky per day since the age of thirteen, as well as "canned heat" and other irritating materials. She had been treated in the past for syphilis.

Physical Examination. The patient was dehydrated, emaciated, with loss of tissue turgor and weighed ninety-three pounds. The only positive physical finding was slight tenderness to palpation in the epigastrium. No abdominal masses were detected. The lungs were clear to auscultation and percussion. No cardiac murmurs were heard.

Laboratory Data. Hemoglobin was 15.3 gm. per cent, hematocrit 47 per cent, white blood cell and differential counts were normal. Urine specific gravity was 1.020 with 20 mg. per cent albumin and many white blood cells per high power field in a catheterized specimen. Blood urea nitrogen on admission was 39 mg. per cent, 20.9 mg. per cent on the fourth hospital day and normal on the sixth hospital day. Serum electrolytes were normal. Prothrombin time was 52 per cent. Bromsulphalein retention was 2.6 per cent in forty minutes, total protein was 8.77 mg. per cent and the albumin:globulin ratio was 3.97:4.80 mg. per cent. Alkaline phosphatase was 11.5 and 9.7 Bodansky units on two examinations. Sputum examinations were negative for acid-fast bacilli and first strength purified protein derivative (PPD) skin test for tuberculosis was positive.

X-ray Examination. Esophagram demonstrated a smooth and gradual incomplete obstruction of the esophagus with marginal irregularity and retained food particles at the level of the ninth thoracic vertebra. The esophagus was widely dilated proximal to the obstruction and peristaltic waves were present in this area. The lesion was seen as a narrow segment 11 cm. in length. The distal esophagus was easily distensible. Repeat esophagram after aspiration of its contents showed the same mucosal irregularity. The chest x-ray film failed to show evidence of pulmonary infiltration.

Early Management. The patient was admitted to the hospital with severe esophageal obstruction. The following orders were written: (1) Clear liquids (60 cc.) every hour; (2) elevate the head of the bed by placing shock blocks under the bedposts; (3) measure intake and output; (4) 1,000 cc. 5 per cent glucose in normal saline followed by (5) 1,000 cc. 5 per cent glucose in water to be administered slowly over four hours; (6) atropine (0.3 mg.) and phenobarbital (15 mg.) intramuscularly every six hours; (7) temperature, pulse and respirations every four hours; (8) weigh daily.

These orders were written as a specific plan of early management. It was known from the patient interview that she could retain her own saliva at this time but not solid or soft foods. Clear oral liquids in small volumes were given frequently to maintain fluid intake. If tolerated, the consistency of fluids and food were to be increased progressively. Sedation and antispasmodics were given parenterally to relax muscle spasm and facilitate the passage of liquids. Elevation of the head of the bed was used as an adjunct to the propulsion of liquids past the obstruction and to minimize regurgitation and aspiration. Intravenous fluids were given to replace the fluid deficit, establish an adequate urinary output and decrease the blood urea nitrogen. Progress of the patient was followed by observing the intake and output, weight and vital signs.

Response to Early Treatment. The patient did not take oral fluids adequately and showed no signs of clinical improvement after twenty-four hours of treatment, other than weight gain derived from the intravenous fluids. An esophagoscopy was carried out using 1 per cent xylocaine topical anesthesia, and a stenosing lesion with normal-appearing mucous membrane was found 32 cm. below the incisor teeth. The area of stenosis was dilated easily with woven dilators from No. 8 French, which would barely pass, to size No. 18 French. A No. 8 French polyethylene feeding tube was inserted through the stricture to maintain fluid intake and permit tube feeding. A biopsy was considered but not obtained because the patient became totally uncooperative at this time and attempted to remove the esophagoscope.

The patient was fed by nasogastric tube and gained from ninety-three to ninety-eight pounds in three days. Antispasmodics and sedatives were continued parenterally. Tube feedings could easily be swallowed around the polyethylene tube three days after esophagoscopy and the tube was removed on the fourth day. Oral intake decreased progressively and her weight dropped from ninety-eight to eighty-eight pounds in the succeeding five days.

Problem. This patient had a history of ingesting irritating and stimulating substances that presumably produced an esophageal stricture with obstruction. Dilatation of the area of stricture was only temporarily helpful in this case. Failure of the prescribed management suggested that the treatment was inadequate to control acid peptic regurgitation or that this was not merely a benign stricture as suspected. The usual cause of esophageal obstruction in a twenty-nine year old woman is a benign stricture. However, one cannot overlook the possibility of malignancy regardless of age or sex.

Repeat esophagoscopy and a biopsy were carried out under general anesthesia to confirm the diagnosis of esophageal stricture or establish the diagnosis of malignancy. The esophagus was dilated with a No. 22 French woven dilator and a feeding tube was inserted. Microscopic examination of the tissue obtained by biopsy demonstrated a well differentiated squamous cell carcinoma in the submucosal layer of the esophagus.

Late Management. Tube feedings were accelerated and the patient received between 2,500 and 3,500 calories for eight of the ten days before operation. Her weight increased from eighty-eight to 105 pounds in ten days. Vitamin K and multivitamins were given by tube and parenterally because the patient had obvious nutritional and vitamin deficiencies resulting from prolonged esophageal obstruction. The measured blood volume deficit was replaced by transfusion with 1,500 cc. of whole blood. Neomycin solution (0.1 per cent) was given orally to prepare the obstructed proximal esophagus when culture results of the esophageal aspirate demonstrated Escherichia coli and streptococci. One gm. of neomycin was given every six hours for four doses and castor oil 30 cc. was given the day before surgery by nasogastric tube to prepare the intestinal tract in the event a right colon interposition operation might be necessary.

Surgery. On December 4, 1957 a left thoracotomy was carried out through the seventh intercostal space and the esophagus was exposed. The tumor mass was found at the junction of the middle and lower thirds of the esophagus, densely adherent to the posterior pericardium and anterior surface of the aorta with no evidence of invasion. The diaphragm was opened and there was no evidence of hepatic metastases or coeliac lymph node involvement. One lymph node was found on the pleural side of the esophageal hiatus which showed evidence of tumor by frozen section. Specimens of the posterior pericardium, adventitia of the aorta, the coeliac and aortic arch lymph nodes were negative for tumor by frozen section. The lower one-half of the

esophagus and its adjacent tissue, two inches of the stomach and a two inch circle of the diaphragm were resected in continuity. Frozen section examination of the proximal and distal lines of resection showed these to be free of tumor. The fundus of the stomach was closed and an infra-aortic end to side esophagogastrostomy was performed. A plastic nasogastric tube was inserted through the anastomosis into the gastric pouch. The phrenic nerve was crushed, and the stomach was sutured to the diaphragm and the prevertebral fascia in the infra-aortic area to avoid tension at the suture line with respirations, coughing, early ambulation and gastric distention. A thoracotomy tube was inserted for drainage of the pleural space and the chest was closed in layers.

Postoperatively, hydration was maintained with 2,000 cc. 5 per cent glucose in water every twenty-four hours for two days. The stomach was aspirated by the nasogastric tube for forty-eight hours. At this time bowel sounds could be heard and the patient passed flatus. A small volume (30 cc.) of normal saline was given every two hours by nasogastric tube for twelve hours and was well tolerated. Tube feedings were reinstituted progressing from skim milk to whole milk and protein enriched tube feedings for three more days. The patient was permitted to drink saline and liquids orally after the fifth postoperative day. The nasogastric tube was removed on the eighth postoperative day and an enriched liquid diet was continued for two more days. The diet then was progressed to a soft diet and later to a regular diet. During the patient's postoperative course her weight decreased from 105 to ninety-nine pounds. After the eleventh postoperative day she began to gain weight and was 108 pounds at the time of discharge.

Pathology. Microscopic examination confirmed the presence of a well differentiated squamous cell carcinoma of the esophagus with a single lymph node involvement on the diaphragm at the esophageal hiatus. No other positive lymph nodes were found. The tumor had infiltrated the muscular wall of the esophagus but had not extended into the surrounding adventitia.

Late Course. The patient has been seen several times since discharge and complains of occasional regurgitation of food which can be avoided by sitting up for two hours after eating. X-ray examination of the esophagus demonstrated slight stenosis at the site of anastomosis and roentgenograms of the chest and abdomen failed to show any evidence of recurrence. Esophagoscopy and dilatation of the anastomosis has been carried out on three occasions because of narrowing at the suture line. Biopsy of the line of resection one year after surgery did not show evidence of local recurrence of disease.

COMMENTS

This case outlines the important diagnostic and therapeutic considerations in the management of a patient with esophageal obstruction whether due to stricture, tumor or foreign body [1]. A history of dysphagia, pain and weight loss regardless of age indicates that an esophagram and esophagoscopy with biopsy should be carried out to confirm the presence of a benign or a malignant lesion [2,3]. It is important that the proximal esophagus be cleansed of retained food particles by a nasogastric tube or by esophagoscopy to allow adequate study of the mucosal pattern. If esophagoscopy is not satisfactory under topical anesthesia in an uncooperative patient, this procedure with biopsy must be carried out under general anesthesia so that a tissue diagnosis can be made.

If the lesion is benign, gradual and repeated esophageal dilatations with silk woven or mercury loaded Hurst dilators may relieve symptoms as long as recurrent obstruction is not produced and if the primary cause of esophagitis can be controlled medically. Passage of a small plastic feeding tube beyond the obstruction into the stomach is helpful to maintain adequate fluid, electrolyte and caloric intake until esophageal mucosal edema subsides. When the patient can swallow saliva and liquids around the feeding tube, this can be removed and the patient's diet advanced slowly. Recurrent obstruction may indicate inadequate medical therapy, a retained bolus of food or an unrecognized malignant lesion.

If the lesion is malignant, fluid loss should be replaced, electrolyte imbalance corrected, caloric intake increased and blood volume deficits measured and replaced. The esophagus proximal to the obstruction should be prepared with oral neomycin solution and repeated aspirations if necessary to correct and prevent infection and reduce to a minimum the opportunity for postoperative disruption of the esophageal anastomosis. The colon should be

prepared with neomycin, castor oil and enemas to permit a colon interposition procedure if an extensive resection or a palliative bypass operation becomes necessary. Vitamins, especially vitamin K, should be given to correct deficiencies resulting from prolonged esophageal obstruction. Sorlate or "Tween 80" may be helpful in aiding gastrointestinal absorption of high caloric and concentrated fat and protein tube feedings. Caution should be exercised in the use of concentrated tube feedings because they produce extreme thirst and dehydration despite weight gain. Hypertonic solutions may produce diarrhea and gastrointestinal intolerance reducing the benefit derived from the tube feedings.

The treatment of choice for carcinoma of the distal third of the esophagus is surgical removal of the tumor, its adjacent lymph nodes, adventitia, pleura and resectable areas of local extension [4]. Prior to resection the mediastinal lymph nodes should be examined and the diaphragm opened to rule out the presence of extensive lymph node involvement or hepatic metastases. The area of the tumor should be inspected to detect evidence of nonresectable extension to the pericardium, heart or aorta. In the absence of local extension or distant metastases the operation of choice is esophagogastrectomy with the removal of at least two inches of esophagus above and below the palpable tumor. Both lines of resection must be examined by frozen section at the time of surgery to be sure an adequate length of esophagus has been removed and that tumor has not spread by lymphatic extension in the esophageal submucosa.

If a curative resection is not technically feasible because of extensive lymph node spread or direct invasion into the mediastinal structures, a palliative resection and esophagogastrostomy or the insertion of one of the available prosthetic esophageal tubes may permit deglutition during the remaining months of life. A bypass procedure using jejunum or colon from the proximal esophagus to the stomach may be done to permit alimentation [5]. If these measures are not technically possible, a nasogastric tube can be guided into the distal esophagus or a gastrostomy performed and irradiation carried out postoperatively.

Follow-up examination of patients with carcinoma of the esophagus should include chest roentgenograms, esophagram and esophagoscopy with dilatation during the first year after operation to avoid stricture. Biopsy at the line of anastomosis at the time of esophagoscopy is useful to detect the presence of recurrent disease early. Observation of weight gain and the general feeling of well being are important guides in determining the benefit from resection for carcinoma of the esophagus.

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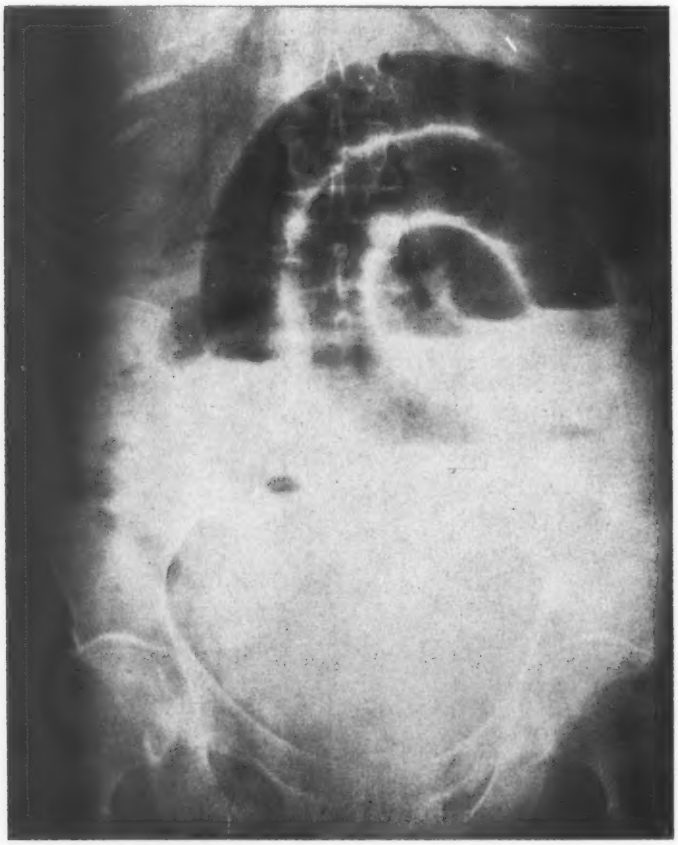
SPECIAL DEPARTMENTS

The Diagnostic Corner

SIDNEY W. NELSON, M.D., *Department of Radiology, The Ohio State University Health Center, Columbus, Ohio*

A classical demonstration of the common type of acute abdomen.



Diagnostic Corner

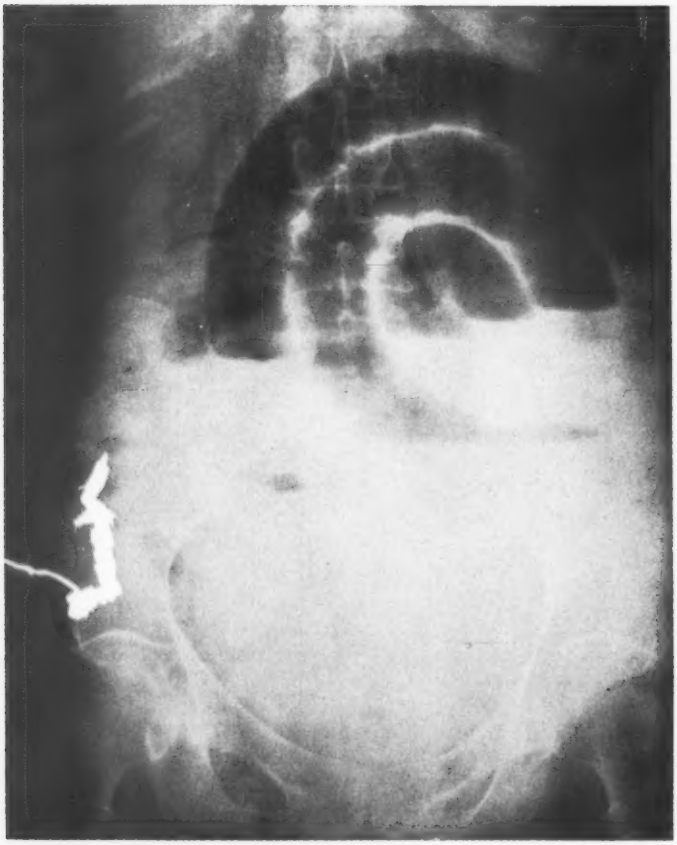
THIS sixty-one year old white lady was admitted to the University Hospital on the morning of July 25, 1953, a few hours after the onset of a mild epigastric distress which gradually became more painful until it actually was a severe cramping pain. The patient vomited several times, and remembered that her pain occurred in rushes and would then disappear for a few minutes only to return later. The patient had had a vaginal hysterectomy at another institution two months prior to the onset of the current illness. Following this previous surgery the patient had had several bouts of cramplike epigastric pain, although they had never become as severe as the present attack and had always subsided spontaneously.

Physical examination showed the patient to be acutely ill with occasional episodes of vomiting. She was obviously having recurrent episodes of abdominal pains and complained of nausea. Blood pressure was 170/100 mm. Hg, pulse was 110 per minute and regular. Chest was normal to auscultation and percussion. The abdomen was slightly distended. The bowel sounds were high pitched and tinkling in character. There was no rebound tenderness or palpable abdominal mass.

Laboratory work showed a red blood cell count of 4.81 million per cu. mm., hemoglobin of 13.8 gm. per cent, white blood cell count 12,150 per cu. mm. with a differential count of 8 per cent nonsegmented neutrophils, 80 per cent segmented neutrophils and 12 per cent lymphocytes. The urinalysis was normal. Supine and upright films of the abdomen were taken. The upright abdominal films (see illustration on facing page) showed interesting findings. *What is your diagnosis?*

Please turn page for answer

Diagnosis: Mechanical obstruction of the small intestine due to simple band adhesion.



Diagnostic Corner

The history of a sudden onset of cramping epigastric pain which gradually increased in severity and was associated with severe nausea and vomiting should certainly make the diagnosis of mechanical intestinal obstruction a logical one, particularly in a woman who had had pelvic surgery two months earlier. The abdominal distention, the high pitched tinkling type of bowel sounds and the moderate leukocytosis are further points in favor of the diagnosis.

The roentgenographic findings in themselves are classical for intestinal obstruction of the mechanical type. The large sausage-shaped, moderately distended air- and fluid-filled loops of bowel are easily identified as small intestine by virtue of their central location and the presence of the valvulae conniventes. Furthermore, the loops are roughly parallel to one another. The presence of the air-fluid levels at different levels in the same loop is further evidence of tonicity of the loop, in contrast to paralyzed loops in which fluid levels frequently are seen at the same level on both sides of a loop. Further strong evidence indicative of mechanical obstruction is the fact that no gas is seen in the colon.

Surgery should not be delayed longer than necessary once the diagnosis of intestinal obstruction is made because of the severe problems of dehydration and electrolyte imbalances. The classical history, physical findings and roentgenographic findings should almost always lead to a correct diagnosis.

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Surgery Court Cases

HOWARD NEWCOMB MORSE,* *Atlanta, Georgia*

GRUGINSKI VS. LANE

Supreme Court of Washington

30 P. 2d 970

The patient, a young man twenty-one years of age, was in an automobile accident and sustained a compound fracture of the humerus about three inches above the elbow. He called upon the surgeon in Castle Rock, Washington, who took him to the hospital at Longview. The arm was bruised and bleeding. A small piece of bone was protruding through the flesh.

An operation was performed, the fracture reduced and the arm placed in an aeroplane splint. The frame portion of the splint was attached to the body, and the portion which sustained the arm projected forward and was sustained by braces in order that the arm might be kept in its natural position. The portion which held the arm was concave and made of aluminum. The arm was bandaged and the patient remained in the hospital for a period of eleven days. Two or three times, while he was in the hospital, the bandages were removed and fresh bandages put on.

After leaving the hospital, the patient went back to Castle Rock and called upon the surgeon two or three times each week. During this time, the bandages were not removed and from time to time additional bandages were applied. When the bandages were removed, approximately three weeks after the patient left the hospital, and the splint was taken off, the patient had Volkmann's contracture. The injury to the arm was permanent. The extent of the injury was such it practically deprived the patient of the use of the arm from the elbow down. The cause of the injury was starvation of the muscles and nerves for lack of arterial blood.

The patient brought an action in the Superior Court of Cowlitz County, Washington, against the surgeon to recover damages for injuries allegedly resulting from malpractice. The patient claimed that the bandages had been placed upon the arm too tightly, and that this shut off the flow of arterial blood and resulted in the condition mentioned. The surgeon defended on the ground that the stoppage of the flow of blood was caused by a blood clot that got into the artery feeding the lower arm at the time of the injury.

If, during the three weeks after the patient left the hospital and before the splint was removed, the hand was excessively swollen and had a blue or purple color, it would indicate that the flow of blood had been arrested by pressure upon the arm. In this instance, the pressure would be the bandages. On the other hand, if the flow of blood was arrested by a blood clot or injury to the nerve, the hand would be pale or have a cadaverous appearance. A considerable number of witnesses, who had seen the hand and arm during the three week period, testified that the hand and fingers were excessively swollen and had a bluish or purplish color.

A jury returned a verdict in the amount of $4,000 for the patient, and the court entered judgment accordingly. The surgeon appealed. The Supreme Court of Washington affirmed the decision of the court below. The Supreme Court declared, "This testimony directly supports the respondent's (the patient's) theory and the medical testimony offered by him to the effect that the bandages were placed and kept upon the arm too tight and that this is what caused the injury."

* Counsellor at Law of the Supreme Court of the United States of America.

GLEASON VS. McKEEHAN

Supreme Court of Colorado

66 P. 2d 808

During pregnancy, the patient, while suffering from severe hemorrhages, entered the county hospital of Larimer County, Colorado, where the surgeon was generally in charge. The surgeon, after examination with another surgeon, upon consultation and recommendation to the patient and her husband, performed a cesarean operation on the patient. A four and a half months old fetus was removed, together with the patient's appendix and tubes, which were diseased. Following the operation, peritonitis developed and the patient died.

The patient's surviving husband filed an action in the District Court of Larimer County, Colorado, against the surgeon for damages as the result of alleged malpractice. A jury returned a verdict in the sum of $5,000 for the surviving husband and the court entered judgment accordingly. The surgeon appealed.

The Supreme Court of Colorado reversed the decision of the lower court. The Supreme Court stated, "He (the surgeon) is not, and never can be, a warrantor of cures or even favorable results. Intervening causes may sometimes thwart the highest skill employed in the accustomed or only procedure known."

BOOK REVIEWS

Syllabus of Laboratory Examinations in Clinical Diagnosis. Edited by Lot B. Page, M.D. and Perry J. Culver, M.D. Revised edition, 580 pages. Harvard University Press, Cambridge, Mass., 1960. *$12.50.*

The editors with the aid of thirty-three contributors and sixteen critics have revised the original *Syllabus of Laboratory Examinations in Clinical Diagnosis* which was edited by Dr. Thomas Hale Ham. Most of the original material has been retained and additions have been made in the areas of inflammation and necrosis, and the interpretation of cardiac catheterization studies and pulmonary function tests.

Realizing the necessity to choose laboratory tests critically, in view of the increasing number of them available today, and to interpret the results of these tests wisely, the editors have again placed emphasis on the interpretation and limitations of laboratory examinations. This emphasis, coupled with concise descriptions of the principles of the laboratory examinations, should be a valuable aid to the physician in carefully selecting laboratory tests and critically evaluating the laboratory findings.

Details of laboratory procedures are excluded except in those procedures which the physician may be called on to perform himself or those which are not as yet included in any other textbook. This limits the usefulness of the book in the laboratory but probably enhances the value to the physician since he thus does not have to sort through material which will be considered irrelevant by him. The inclusion of a very adequate and up-to-date bibliography, however, offsets the lack of details of laboratory procedures and renders the book valuable to both the physician and the laboratory worker.

GERALD L. ENDAHL, PH.D.

Enzymes in Clinical Medicine. By Irving Innerfield, M.D. 334 pages. McGraw-Hill. New York, 1960. *$11.50.*

This book represents a detailed review of the historical, experimental and clinical evidence regarding the use of enzymes as therapeutic and diagnostic agents. This will be particularly of interest to surgeons. The central proposition of this book is the concept that, by altering the rate of proteolytic phenomena in inflamed tissue, the inflammatory reaction is significantly modified and tissue healing is encouraged. Furthermore, the author believes that if enzyme therapy is instituted earlier in the course of an evolving inflammatory reaction, it may be possible to reverse such interstitial abnormalities as edema, viscous deposits, tissue impermeability and ischemia and such end results as tissue necrosis and infection may be prevented.

The methods of administration are discussed in detail. The author points out that with the parenteral use of enzyme therapy, the Arthus reaction is a possibility and must be borne in mind. At the time of publication of this book, the author had not observed the Arthus reaction in any of the patients receiving buccal enzyme therapy and he believes that when possible the buccal route should be used. In addition to avoiding unpleasant local side effects associated with the intramuscular route, such as pain, induration and the Arthus reaction, the buccal route makes possible repetitive daily doses and long term maintenance therapy.

The clinical indications are discussed and these cover a wide range of conditions including bronchiectasis, empyema, bronchopleural fistula, acute thrombophlebitis, diabetic cellulitis with gangrene, traumatic and inflammatory edema. Specific indications in the fields of ophthalmology, urology, otolaryngology and dermatology are discussed.

In a rather extensive chapter, the author discusses the diagnostic enzymes and their value. In the final chapter many of the practical points in using enzyme therapy are discussed. These include the contraindications to enzyme therapy, dosage schedule, side effects and other

pertinent information. The bibliography is extensive and is of value to anyone interested in this subject.

ROBERT J. DURAN, M.D.

Cellular Aspects of Immunity. Edited for the Ciba Foundation by G. E. W. Wolstenholme, O.B.E., M.A., M.B., M.R.C.P. and Cecilia M. O'Connor, B.SC. 495 pages. Little, Brown & Co. Boston, 1960. *$10.50.*

Workers throughout the world are greatly indebted to the Ciba Foundation for making such symposia possible. This symposium, in addition to bringing together virtually all the major workers in this field to present the results of their studies, many of which have not yet been published, demonstrates clearly how little the artificial separation of immunology, histochemistry, electron-microscopy and protein chemistry has come to mean. Workers in all these fields will find much of interest, and no one seriously interested in any of these fields can afford to ignore this book. The sections on the clonal selection theory of antibody formation, and on the graft versus host and host versus graft reactions are particularly interesting.

C. R. MACPHERSON, M.D.

The Office Assistant. Second Edition. Portia M. Frederick and Carol Towner. Foreword by George F. Lull, M.D. 407 pages. W. B. Saunders Co. Philadelphia & London, 1960. *$5.25.*

The authors report that 65 per cent of physicians hire only one girl and her duties are multiple as she fulfills all of the possible roles that present themselves. As a receptionist, bookkeeper, record librarian, office assistant and public relations officer for the physician, the responsibilities are great. This book takes up the individual problems and gives helpful suggestions in accordance with medical ethics and the many pecularities that are incidental to a physician's practice. Such things as telephone technic, appointments, handling of the mail, keeping of records, credit and financial assistance and the important aspects of helping the physician in his examinations and treatments are taken up in detail. The care of instruments, sterilization and principles of pharmacology and immunology are explained. In brief, this is a well documented reference book which merits a place in the office assistant's desk for thorough reading and digestion.

C. JOSEPH DELOR, M.D.

Procedures in Vascular Surgery. Richard Warren, M.D. Illustrated by Helen C. Lyman. 211 pages. Little, Brown & Co. Boston, 1960. *$12.00.*

This is a useful atlas for the management of all aspects of vascular disease. The discussion of each disease process includes a presentation of the objective of surgery, the indications for surgery, the contraindications, planning, preparation and the operation itself. Illustrations outline the recommended incisions and approaches and progress through each phase of the operative procedure. Postoperative management is discussed with special emphasis on specific trouble points which must be observed. There is wide coverage of every phase of vascular surgery. Included is the management of aneurysmal, ischemic and embolic disease of all areas as well as the principles of related surgical procedures such as sympathectomy and amputation.

This book is concise and well organized. The illustrations are simple and informative. Adequate space has been included under each category for additional notes on any particular procedure. This book would be an asset in the general surgeon's library.

WILLIAM G. PACE, M.D.

Complications in Surgery and Their Management. Curtis P. Artz, M.D. and James D. Hardy, M.D. 1075 pages. W. B. Saunders Co. Philadelphia & London, 1960.

The experience of seventy-one contributors is combined because of their special interests and experience, making this book an authoritative reference for complications of general surgery. The material is arranged in fifty-seven chapters with only pertinent material included. Reading is made interesting and easy by the short, clearly written sections. A generous index provides a quick reference guide.

Preoperative problems which may lead to operative or postoperative complications are presented. Complications peculiar to all operations as well as those related to specific operations are discussed. Certainly the authors' stated purpose of warning against common complications with suggestions for prevention as well as providing the best available knowledge for therapy is well met.

I make no reservation in recommending this book to all practicing surgeons, residents in surgery, interns and medical students. This book is a necessary and valuable addition to surgical literature.

R. C. MCPHERSON, M.D.

Clinical Applications of Bronchology. By Dezso Kassay, M.D. 225 pages. McGraw-Hill Book Co. New York., 1960. *$15.00.*

Clinical Applications of Bronchology is a small book written for the medical student, general practitioner or other physician not specializing in diseases of the chest. The text is well organized and the book is easy to read. It is also correct and authoritative. The illustrations, both the reproductions of roentgenograms and the line drawings, are clear. They correctly illustrate the textual references.

W. H. S.

Progress in the Treatment of Fractures and Dislocations, 1950–1960. By Thomas B. Quigley, M.D. and Henry Banks, M.D. 102 pages. W. B. Saunders Co., Philadelphia, 1960. *$2.50.*

This review, which has appeared in *The New England Journal of Medicine* as one of a series of Progress Reports in medicine, is a reaction of the authors to studies published during the past decade.

Advances in the last ten years, they point out, are relatively few, although the possibility of use in the future of chemical substances for internal fixation has been explored. The authors then discuss the current turns in specific fracture problems in some detail.

It is an interesting review with a valuable current up-to-date bibliography.

T. L. M.

Postmortem Homografts. By James B. Brown and Minot P. Fryer. 64 pages. Charles C Thomas. Springfield, Ill., 1960. *$5.50.*

This short monograph is readable, clear and concise with good illustrations and charts. It is a distinct contribution to the field of homografting as far as its use in burns. The value of postmortem skin in the burn patient and the good postburn results is well documented. This volume is presented as an addition to burn therapy knowledge and points out that at the present time autografts are the only sure permanent grafts, but postmortem homografts are a valuable asset.

The authors have presented the material adequately for understanding by laymen and physicians alike.

F. M.

Virus Virulence and Pathogenicity. Ciba Foundation Study Group No. 4. Edited by G. E. W. Wolstenholme and Cecilia M. O'Connor. 114 pages. Little, Brown & Co. Boston, 1960. *$2.50.*

This book is definitely for the specialist in virology and/or epidemiology and is a most fascinating and thought-provoking discussion of some of the problems inherent in the study of viral virulence and pathogenicity. The discussion points out clearly the gaps in our knowledge and the lines along which further study must develop, which is, presumably, the main purpose the study group had in mind.

C. R. M.

Surgery in the Aged. Edited by Frank Glenn, M.D., S. W. Moore and John M. Beal, M.D. 534 pages. McGraw-Hill Book Co., Inc. New York, 1960. *$17.50.*

From the outset, the topics covered in this book and the concise method of presentation provide enjoyable reading. Not only is the subject matter timely, but most points covered may well be applied to young patients requiring surgery as well as to the aged.

Physiologic considerations together with preoperative and postoperative care in the elderly patient make up the first part of the book. This section is followed by discussions of surgery in the different regions of the body.

Surgical interns, residents and staff should be familiar with this text. Medical students studying surgery would also find this book to be a ready, easily understood and authoritative reference.

R. C. McP.

The Concise Encyclopedia of Modern Surgery. By James Hale Rutledge, M.D. 308 pages. Chilton Co. Philadelphia, 1960. *$8.00.*

This text is beautifully written in a pleasant and easy style, and is directed toward the layman or the individual with minimal or no basic indoctrination in the field of medicine or surgery. It would be applicable for the student nurse, the technician or the beginning medical student. Most of the questions raised, or the topics covered, are those commonly inquired into by the patient. The simplicity of approach to each situation and the clear concise and easily understood answers make this book enjoyable. The complete explanation of hospital procedures and the reasons behind them makes this book valuable for education of the patient as well as for preliminary indoctrination of professional personnel.

W. G. P.